Antonio Leone Carmela Gargiulo
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Environmental and territorial modelling for planning and design

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This book collects the papers presented at the 10th International Conference INPUT 2018 which will take place in Viterbo from 5th to 8th September. The Conferences pursues multiple objectives with a holistic, boundary-less character to face the complexity of today socio-ecological systems following a systemic approach aimed to problem solving. In particular, the Conference aims to present the state of art of modelling approaches employed in urban and territorial planning in national and international contexts.

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This book is the latest scientific contribution of the "Smart City, Urban Planning for a Sustainable Future" Book Series, dedicated to the collection of research e-books, published by FedOAPress - Federico II Open Access University Press. The volume contains the scientific contributions presented at the INPUT 2018 Conference and evaluated with a double peer review process by the Scientific Committee of the Conference. In detail, this publication, including 63 papers grouped in 11 sessions, for a total of 704 pages, has been edited by some members of the Editorial Staff of "TeMA Journal", here listed in alphabetical order:
- Rosaria Battarra;
- Gerardo Carpentieri;
- Federica Gaglione;
- Rosa Anna La Rocca;
- Rosa Morosini;
- Maria Rosa Tremiterra.

The most heartfelt thanks go to these young and more experienced colleagues for the hard work done in these months. A final word of thanks goes to Professor Roberto Delle Donne, Director of the CAB - Center for Libraries "Roberto Pettorino" of the University of Naples Federico II, for his active availability and the constant support also shown in this last publication.

Rocco Papa
Editor of the Smart City, Urban Planning for a Sustainable Future" Book Series
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INTRODUCTION

Between 5th and 8th September 2018 the tenth edition of the INPUT conference took place in Viterbo, guests of the beautiful setting of the University of Tuscia and its DAFNE Department.

INPUT is managed by an informal group of Italian academic researchers working in many fields related to the exploitation of informatics in planning.

This Tenth Edition pursed multiple objectives with a holistic, boundary-less character, to face the complexity of today socio-ecological systems following a systemic approach aimed to problem solving. In particular, the Conference will aim to present the state of art of modeling approaches employed in urban and territorial planning in national and international contexts.

Moreover, the conference has hosted a Geodesign workshop, by Carl Steinitz (Harvard Graduate School of Design) and Hrishi Ballal (on skype), Tess Canfield, Michele Campagna.

Finally, on the last day of the conference, took place the QGIS hackfest, in which over 20 free software developers from all over Italy discussed the latest news and updates from the QGIS network.

The acronym INPUT was born as INformatics for Urban and Regional Planning. In the transition to graphics, unintentionally, the first term was transformed into "Innovation", with a fine example of serendipity, in which a small mistake turns into something new and intriguing. The opportunity is taken to propose to the organizers and the scientific committee of the next appointment to formalize this change of the acronym.

This 10th edition was focused on Environmental and Territorial Modeling for planning and design. It has been considered a fundamental theme, especially in relation to the issue of environmental sustainability, which requires a rigorous and in-depth analysis of processes, a theme which can be satisfied by the territorial information systems and, above all, by modeling simulation of processes.

In this topic, models are useful with the managerial approach, to highlight the many aspects of complex city and landscape systems. In consequence, their use must be deeply critical, not for rigid forecasts, but as an aid to the management decisions of complex systems.

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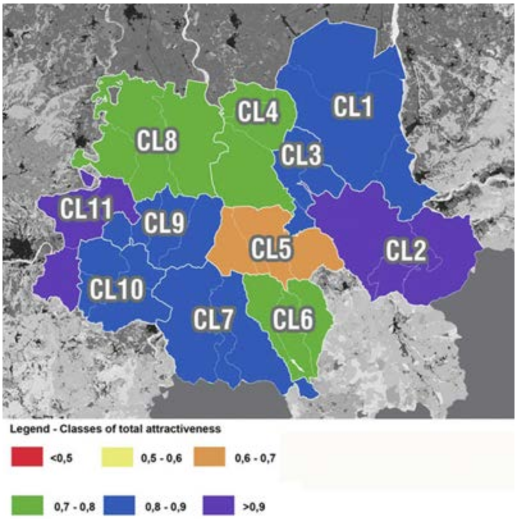

AN INTEGRATED EVALUATION MODEL

FOR SHAPING FUTURE RESILIENT SCENARIOS IN MULTI-POLE TERRITORIAL SYSTEMS

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ABSTRACT

In the present paper an integrated evaluation procedure is considered, with the aim of evaluating the ecological and economic synergies within an environmental system. The case study chosen to test this procedure is the Monferrato Ovadese in the province of Alessandria (Piedmont, Italy). The territory, which includes almost 40 municipalities, was divided into a system of 11 clusters, that were treated as interactive poles of the territory itself.
This integrated procedure uses a system of ecological and economic indicators. For landscape ecology, the indicators were introduced as coefficients, which predict the transformation scenarios of the environmental system under observation. For the economics, indicators were integrated through a Multicriteria Analysis in order to define a super-indicator, which may be interpreted as a measure of attractiveness of the poles inside the environmental system. The attractiveness was subsequently set as the critical parameter of a dynamical system represented by the mathematical model of a Lotka Volterra type, which simulated people flows within the territory. This study demonstrates how this novel evaluation procedure can be used to support the decision-making process in the choice of sustainable territorial and urban actions.

KEYWORDS

Indicators and indexes; Mathematical modelling; Multicriteria Analysis; Integrated Evaluation Model

1 INTRODUCTION

The preservation and enhancement of the whole environmental system represent one of the main challenges of the Anthropocene (Crutzen, 2005).
Assessing the resilience of environmental systems is currently considered to be a field with high margins of development and improvement at all scales (Cutter, 2016). There is an urgent need to shape territorial transformation scenarios and support the governance in preserving environmental systems.
The development of evaluation methodologies could provide useful support for the planning, and in this context, the integration of them in multidisciplinary and interdisciplinary terms may carry useful insights (Cutter, 2016; Pearce & Turner, 1990; Sharifi, 2016).
The present paper will assess the resilience through an integrated evaluation model, which considers a system of indicators and indexes to measure the resilience capability in ecological and economic terms and employs a mathematical model to investigate people dynamics over time. This evaluation model has been employed in a real case study in Piedmont region (Italy): the Monferrato Ovadese.
The paper is structured as follows: section 2 focuses on the methodology; section 3 proposes a description of the case study; section 4 describes the results obtained by the system of ecological and economic indicators and by the application of a mathematical model of a Lotka-Volterra type; section 5 concludes with some remarks and future perspectives.

2 METHODOLOGY

This paper proposes an integrated evaluation methodology, which considers a system of indicators and indexes to assess the resilience of the municipalities of the Monferrato Ovadese in ecological and economic terms as well as a mathematical model, employed to investigate the people dynamics over time and shape resilient scenarios. More specifically, we consider a system of indicators which can be divided into two sub-systems, namely the ecological indicators and the economic indicators.

2.1 THE SYSTEM OF INDICATORS

Ecological indicators

Generally, complex systems are interesting because they show a non-linear dynamics which affect the ecological stability of territories at macro and micro scales (Folke, 2010; Gunderson & Holling, 2002; Holling, 1973). Additionally, this dynamics can be also influenced by the impact of human activities. For these reasons, the sub-system of ecological indicators considers specific variables deduced by GIS data and evaluated for all municipalities of the considered area (Tab. 1).

Economic indicators

The sub-system of economic indicators is useful to assess the economic value of the Monferrato Ovadese. The economic indicators are organized according to the "value tree" approach proposed in the Multicriteria Decision Analysis (MCDA), which is generally employed to solve complex problems (Saaty, 1980). This is an appropriate technique for the assessment of environmental systems (Assumma et al., 2016; Assumma et al., 2017, 2019; Brunetta et al., 2017, 2018; Tagliafierro et al., 2013). The economic indicators and indexes are described in Tab. 2. It has to be noticed that the economic indicators have been assessed for all Municipalities in the area under investigation.

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Ecological Indicators		Unit	Formulas
v_i	Extent of green areas of high ecological quality	%	$V_i = \sum A_v$ with BTC > 2,4/ A_{tot} where A_v=green areas with BTC > 2,4 A_{tot}= total area of the system
m_i	Biological energy	Mcal/(m^2·year)	$m_i = \sum^{m_i}_{j=1} B_{ji} \cdot s_{ji}$ where B_{ij}= BTC index of biotope j ∈ sector i s_{ji}=surface of biotope j ∈ sector i
h_i	Dispersion of urban areas	%	$h_i = \sum P_e / P_{tot}$ where P_{tot}= Total perimeter of the system P_e= Perimeter of urbanized areas
U_i	Intensity of urban areas	%	$U_i = 1 - A_e / A_{tot} \leq 1$ where A_e= area of urbanized areas A_{tot}= total area of the system
C_i	Connectivity index	%	$c_i = \sum_{k \in Ii} (B_i + B_k)/(B_i^{max} + B_k^{max}) \cdot H_{ik} \leq 1$ $c = 1/n \sum^{n}_{i=1} c_i$ where B_i and B_k= BTC of I and k ecological sectors Bi^{max} and Bk^{max}=maximum BTC of i and k ecological sectors H_{ik}= total length of the barrier between sectors i and k with a permeability index ≤1
r_i	Intensity of impermeable barriers	%	$ri = \sum A_{ip} / A_{tot}$ where A_{ip}= area of impermeable barriers A_{tot}= total area of the system
k_i	Dispersion of impermeable barriers	%	$k_i = \sum P_{ip} / P_{tot}$

Tab. 1 The system of ecological indicators defined from GIS data

2.2 EVALUATION OF THE INTEGRATED INDEX

The ecological and economic indicators have been aggregated in two specific indexes that represent the ecological and economic values of the system under investigation. The ecological index is calculated as the arithmetic mean of the values of the related indicators, whereas the economic index comes from a weighted average of the related indicators, according to the weights defined with a multidisciplinary panel of experts based on the AHP (Saaty, 1980). The last step of evaluation consists in the calculation of an integrated ecological-economic index, say A_i, that is the average between the ecological and economic indexes previously calculated. Such index aggregates the ecological and economic values of the system, and thus this step provides an overall vision of the considered territory.

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Component	Economic Indicators	Unit	Economic Indexes
Agriculture	DOP Farms	no.	A_{dop}= DOP Farms [C]/Tot. Farms [S]
	BIO Farms	no.	A_{bio}= BIO Farms [C]/Tot. Farms [S]
	Workers in DOP Farms	no.	W_{dop}=Workers in DOP Farms [C]/ Tot. Workers in Farms [S]
	Workers in BIO Farms	no.	W_{bio}= Workers in BIO Farms [C]/Tot. Workers in Farms [S]
	Utilized Agricultural Surface	ha	UAS= UAS [C]/ Area [S]
Tourism	Arrives	no.	TUR= arrives [C]/presences [C]
	Presences	no.	
	Total beds	no.	PT= Total beds [C]/ Total beds [S]
	Beds in agritourism	no.	PL= Beds in farmhouses [C]/ Total beds [S]
Real Estate	Real estate value of building residences	€/m^2	VIR= Average real estate value [C]/ Average real estate value [N]
	Average Agricultural Value	€/ha	VAM= Average agriculture value [C]/ Average agriculture value [N]
Forestry	Forestry farms	no.	A_{for}= Forestry farms [C]/ Area [S]
	Forestry surface	ha	S_{for}= Forestry surface [C]/ Area [S]
	Forestry workers	no.	W_{for}=Workers in forestry farms [C]/ Workers in forestry farms [S]

Notes: C= cluster, S= System, N=Nation

Tab. 2 The system of economic indicators employed to assess the resilience capability of the case study (Source: Assumma et al., 2016, 2019; Bottero, 2011; Brunetta et al., 2018)

3 CASE STUDY: DESCRIPTION OF THE TERRITORY

The Monferrato Ovadese is a multi-pole territorial system of Piedmont, which extends for 60.000 hectares between the province of Alessandria and the region of Liguria. The lands of the Monferrato Ovadese are defined as "middle lands" because the historical settlements developed according to the geomorphological characteristics and the territorial vocation to cross the Appennines for commercial purposes.
Moreover, the Monferrato Ovadese touches the Unesco site "Vineyard landscapes of Piedmont, Langhe, Roero and Monferrato" (2014) by Strevi, and this represents an opportunity of growth and development, especially due to the influence of both Piedmontese and Ligurian history, culture and traditions (Assumma et al., 2017). In detail, the territory under examination is constituted by 37 municipalities that have been structured in 11 homogeneous territorial clusters described as follows,

CL_1 (Novi Ligure)	CL_2 (Arquata Scrivia)	CL_3 (Pasturana)	CL_4 (Basaluzzo)
CL_5 (Silvano dOrba)	CL_6 (Lerma)	CL_7 (Ovada)	CL_8 (Predosa)
CL_9 (Rocca Grimalda)	CL_{10} (Cremolino)	CL_{11} (Strevi)	

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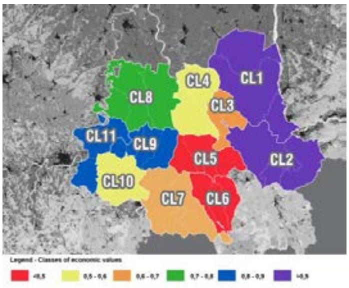
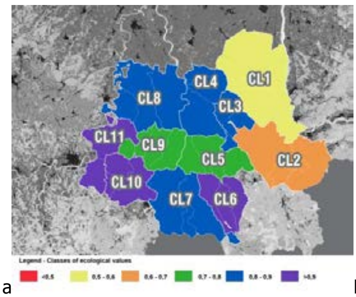
4 RESULTS

4.1 CALCULATION OF THE OVERALL ATTRACTIVENESS

Following the methodology described in section 2, a spatial visualization of results is illustrated in Figg. 3a, 3b and 3c. The Clusters 1 and 2 record high economic values because there are many industrial activities. The Cluster 11 also shows very high economic and ecological values, due probably to the proximity to the Unesco site. By contrast, the Clusters 3, 4, 7 and 10 show average values. Specifically, the Clusters of Novi Ligure (CL1) and Arquata Scrivia (CL2) record very high economic values, due to the presence of one of the biggest fashion outlets in Europe and many other commercial poles, which promotes a continuous flow of people. Therefore, such Clusters record medium to poor ecological quality, because of the commercial vocation of these territories. The Cluster of Lerma (CL6) records a poor economic value, because its activities are focused on a seasonal tourism and the economy is based on the local cultivation of different products, including production of wine. Moreover, the Cluster 6 records a very high ecological quality because it includes protected areas of the Piedmontese Appennine.The Cluster of Strevi (CL11) records both a very high ecological quality and a high economic value, mainly due to the fact that Strevi represents the "natural" door of the Unesco site. This also determines positive effects in ecological and economic terms for Clusters 8, 9 and 10. The economic and ecological indexes have been aggregated in a final spatial index, the Total Attractiveness as illustrated in Fig. 3c. The index of Total Attractiveness represents a positive frame of the Monferrato Ovadese, with good and very high values. The only exception is recorded by the Cluster 5, which maintains anyway a medium value of Total Attractiveness.



a



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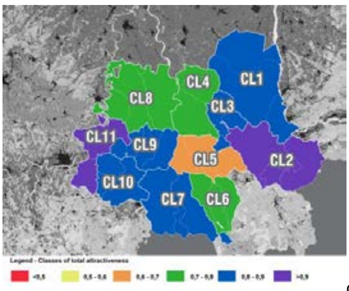

c

Fig. 3 Spatial results of economic values (a), ecological values (b) and total attractiveness (c) (Own elaboration, 2018)

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4.2 THE MATHEMATICAL MODEL

In this paper, the integrated indicators have been introduced as coefficients of a system of ordinary differential equations of a Lotka-Volterra type proposed by Monaco & Rabino (1984) and then revisited in recent contributions (Assumma et al., 2016; Monaco & Servente, 2006; Monaco, 2015;). This mathematical model is used in the simulation of population dynamics, in connection with the attractiveness factor. In addition, the model predictions are used in the interpretation of the population dynamics in terms of resilience factor. The first term of equation (3) takes into account the attractiveness A_i for people present in the pole *i* through a logistic expression (Murray, 2002), while the second term takes into account the attractiveness of pole *i* on people present in others poles *j*. The mathematical model used here takes the form:

$$P'_i=A_iP_i(t)(1-P_i(t)/S_i)+\sum^{n}_{j\neq i} A_i/A_j[1- (d_{ij}/d_M)P_j(t) \qquad i=1, 2,..., n \qquad (3)$$

where

P'_i= time derivative of P_i

P_i= population present in the pole i

A_i and A_j= attractiveness index of poles i and j

d_{ij}= distance between the poles i and j

d_M= maximum distance recorded between poles

S_i= threshold of maximum number of people in the pole i

We use the model presented in this section to study the population dynamics on Piedmont, a region in northern Italy that shares different structuring and qualifying landscape components.

Fig. 4 shows the time evolution of all populations in the time interval [0; 0,05] (the time is measured in arbitrary scale).

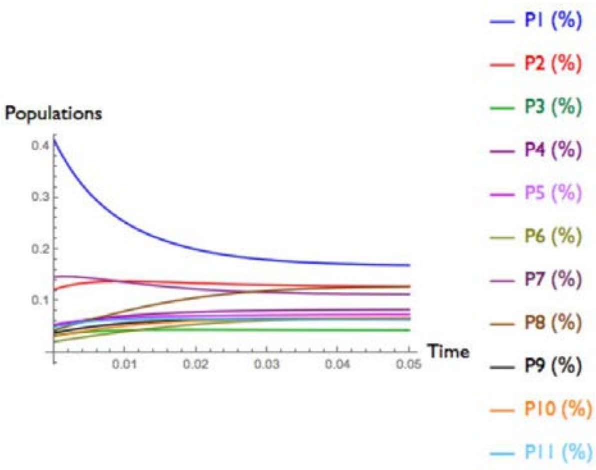

Fig. 4 Time evolution of all populations in the interval (0; 0.05). Own elaboration, 2018

Thanks to the ecological and economic attractiveness, the mathematical model can predict the potential variation of populations present in the considered multi-pole territorial system. The results obtained are illustrated in Fig. 4.

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5 CONCLUSIONS

The integrated evaluation methodology presented in this paper provides useful insights to assess the resilience of the Monferrato Ovadese in ecological and economic terms. This innovative tool can support the decision-making process to shape future resilient scenarios also to answer the domain of prevention and mitigation of natural disasters and human activities. As a future perspective, a sensitivity analysis can be useful increase the robustness of the set of weights considered.

With regard to the mathematical model, further studies would be useful, in particular if collecting a wider set of data to make simulations in the past with the purpose to improve the adequacy of the mathematical model. Another future perspective could be the use of this integrated evaluation methodology in a real land use intervention with the purpose of planning scenarios of decision-making utility.

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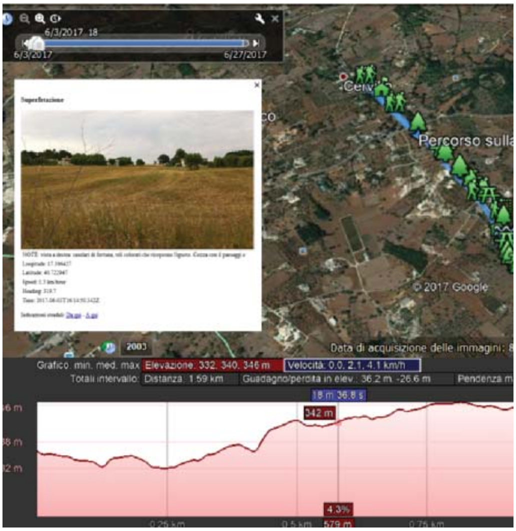

FEATURES OF AGENTS' SPATIAL KNOWLEDGE IN PLANNING OPEN SPACES

A PILOT STUDY

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ABSTRACT

Spatial environments have been largely studied over time, under different perspectives. Under a cognitivist perspective, they represent knowledge-intensive, meaningful spaces and entities that human agents relate to and adapt during their existence.
The comprehension/identification of space fundamentals by human agents can be of great interest in strategic planning, in that they may represent structures, pillars, invariant, resilient characters of the environment, on which to build/plan the layout and development of regions and towns.
The role of spatial cognition is often expressed through tacit or implicit aspects, made of perceptions, emotions, sensations relating to space, difficult to identify but characterizing the environment explored in a fundamental way. As a matter of facts, these are fundamental elements towards effective planning strategies and environmental decisions.
In particular, this work investigates these aspects of spatial knowledge in agents moving in spaces with reduced - in particular extremely reduced – population. In fact, these are apparently unstructured contexts with respect to settlement areas, where aspects concerning sensations can represent essential spatial variables in terms of structuring and interpreting spaces.

KEYWORDS

Spatial Cognition; Open Space; Spatial Variables; Environmental Planning

1 INTRODUCTION[1]

Spatial environments have been largely studied over time, under different perspectives. Under a cognitivist perspective, they represent knowledge-intensive, meaningful spaces and entities that human agents relate to and adapt during their existence (Proulx et al., 2016). They are intrinsically based on dynamic complexity, therefore trying to understand the typical spatial behaviours of a human agent is often hard task, inducing planning as well as managing problems in many domains (Denis & Loomis, 2007). For example, they are typically intricate tasks when trying to simulate spatial behaviours within AI or robotic building layouts. Therefore, in the quest for understanding the complexity of space environments, it is important to search for the possible 'fundamental' features of such spatial complexity from the standpoint of agents who have act and relate to the space.

The effort of searching for fundamental spatial features is not an easy task, though. In fact, there is a potential naivety in speaking about space 'fundamentals' as opposed to space ancillary, ornamental qualities (Goodman, 1951). Particularly experimental literature often shows that not always there is clear distinction between substance and ornament, content and form in spatial analysis (Borri & Camarda, 2013).

Understanding the way in which human agents think and operate in given spaces – i.e., space ontology, from a perceptual point of view – is commonly essential for AI robotics. In turn, because of the well known circularity between AI and cognitive science, the development of AI robotics devices help in understanding spatial human behaviours for decisionmaking. Therefore, the comprehension/identification of space fundamentals by human agents can be of great interest in strategic planning, in that they may represent structures, pillars, invariant, resilient characters of the environment, on which to build/plan the layout and development of regions and towns.

The research on the spatial knowledge forms of living agents in both micro-scale (buildings or their aggregates) and meso-scale spaces (cities as sets of built spaces and open spaces) is today in progressive development, in environments of automatic computation of psychology or engineering (Borri & Camarda, 2010, 2013). It offers ideas to engage with, for example in problems of orientation and navigation, as well as ontological intelligence.

In particular, the macro-scale concerns spaces that are still predominantly configured in a pre-anthropic way as are deserts, mountains, forests, oceans, and in perspective also spaces outside the planet. Research on forms of spatial knowledge at the macro-scale is still limited (Dolins & Mitchell, 2010; Proulx et al., 2016).

The present work investigates on such aspects of spatial knowledge in agents moving in spaces with reduced - in particular extremely reduced – population. In fact, they are spaces that are apparently unstructured, as compared to community settlements, where aspects of sensations can constitute spatial variables that are essential in terms of structuring and interpretation of spaces.

The way in which we find the progressive identification and enrichment of information during navigation in this type of space is analyzed here. In particular, we are interested in the essential information for orientation in navigation and for the identification of the resources necessary to guarantee operative systems of relationship between agents and between agents and spaces.

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[1] Authors developed the present study together, as a common research work. In this framework, G. Mastrodonato wrote chapter 2, D. Camarda wrote the remaining chapters.

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Within the above research framework, the paper is then organized as follows. After the present introduction, a digression on the research background on spatial cognition issues is carried out in chapter two. The third chapter briefly deals with the main characters of the research project where the present study is structured. Chapter four shows the experimental case study carried out here, with essential, describing methodology and discussing the results of the developed analysis. Brief concluding remarks are reported in the end, dealing with achievements, suggestions and possible follow-ups.

2 SPATIAL COGNITION RESEARCH BACKGROUND

When dealing with cybernetic and artificial intelligence studies, we find large reasoning about spatial cognition features, as they are important for operational planning. Rather interestingly, they put town a basic distinction between structured and unstructured spaces. Fundamentally, it parallels a similar distinction between spaces geometrically simple (elementary profiles, few unexpected events, few secondary items, few decisions required) and spaces geometrically complex (composite profiles, recurrent unexpected events, many secondary items and many decisions required) (Danziger & Rafal, 2009; Georgiev & Allen, 2004; Kelly & Bischof, 2008). It is easy to understand that a robot develops movements and learns surrounding spaces more straightforwardly in simple geometries, so determining more identifiable cognitive situations. This seems rather clear, although robot agents can typify great part of reality and are able to move also in unstructured world - like human agents.

A different situation occurs in human agents. A reasonably recognizable space is for us geometrically simple, empty, maybe unidirectional space. This is represented, for example, by an interior corridor, long and empty, with a series of doors, windows, skylights. It consists of a point of origin and an end point, with no lateral intersections. This space could be assimilated to the arc of a graph, it is certainly simple and can be walked by the human agent with little attention. On the other hand, the human agent considers complex a very crowded space, with a multi-dimensional geometry that is difficult to recognize. This is, for example, an open space, like a rural area or a city fair, with an unclear form, origin, endpoint, thus demanding specific attention. A human walks casually through it, with the frequent risk of colliding with the imprecise trajectories of people, or getting lost, or losing her / his friend or child who still does not know how to move in a complex space. Such complex spaces may suggest human agents a preliminary action of memorization of characteristic landmarks with the aim of replace an incomprehensible "structure" or "geometry" (de Hevia & Spelke, 2009; Gero & Tversky, 1999; Hirtle, 2003). Philosopher John Goodman (Goodman, 1951) argued on a distinction between 'structure' and 'ornament', in human perceptions of complex spaces. The representation space is increasingly considered as a multiform issue, complex and intrinsically non-reducible. It also changes with time, but with features that are not always so obvious as traditionally expected (Day & Bartels, 2008; Pouget et al., 2002). Such situation is even more complex, if possible, when dealing with the potentials and problems of orientation and spatial knowledge in endogenous and exogenous agents in spaces with reduced - in particular extremely reduced - population. It is a matter of identifying and experimentally analyzing variables and systems of latent variables in spaces with reduced (or non-existent) information content on the anthropic levels of spatial structuring. It is a question of laying the foundations - also through experimentation on human agents - of the modelling of functional (operational) cognitive systems that are suitable for these spaces. In general, these are cognitively poorly structured spaces. However, we assume the research hypothesis that a good cognitive structuring of such large spaces of nature, hostile to itself to the intensive population, is possible when the essential (ontological) latent variables are identified. These variables are therefore investigated,

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which are considered quite similar to those of high-population spaces with a high degree of randomness of interactions and transformations.

Starting from the available literature, the work aims to analyze some experiential narratives focusing on the themes of the cognitive characterization of rural paths. In particular, the results of experiments conducted with students of the engineering school of the Polytechnic of Bari are analyzed in a modelling perspective.

The general research objective of the experimentation is to investigate the fundamental characteristics of the open space through spatial cognition by agents who navigate within open spaces themselves. Relevant data are analyzed in order to draw correlations between elements present in protocols collected by ad-hoc experimentation. The specific objective of the present paper is to analyze the possible dependence of spatial sensations and perceptions from the other physical and relational elements that characterize the rural open space.

3 THE CASE STUDY

During the past months, an experimentation campaign was carried out with 180 students of the 2nd year of the master's degree in Building Systems, Urban Planning course. In this experimentation, each agent had to choose and travel a route in an open rural space, photographing elements that he considered to be of interest and recording sensations, perceptions and / or emotions along the way. The track, the places of interest and the notes were recorded in a geo-referenced way through smartphones, with appropriate software app. Subsequently, the agent reported her/his personal and residential details on the online portal related to the experimentation. The present analysis was carried out on a reduced sample of 16 observations out of 180 protocols. This is a small part of the entire population involved, since the work of control, formatting and normalization of the great amount of data is only at the beginning. Apart from personal details, data are mostly stored on kml/kmz (Google Earth) files, from which numerical elements are then drawn out in the form of string, text and graph (Fig. 1 and 2). In particular, textual notes taken by each agent along the route have been analysed by using simple data mining software Concordance, to draw out word and concept frequencies. The aggregation of textual concepts into categories has then been developed by manual ex-post analysis (Le Yaouanc et al., 2010). In the end, the complete database is reported in Fig. 3, whereas specifications of acronyms, including the clusters of concepts grouped by synthetic categories, are reported in Fig. 4.

Fig. 1 Example of track with the location of photo takings

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Fig. 2 Example of track with photo and note taking locations

#	ID	Town of residence	Explored location	Residence-location distance (km)	Min altitude (m)	Level difference (m)	Length (km)	Duration	Buildings	Fauna	Flora	Natural landscape	Dissipation and pollution	Sensations	Plants and installations	Streets	Abstract features	topology
				LUO	ALT	DIS	LUN	TEM	COS	FAU	FLO	PAE	INQ	SEN	TRA	VIE	ABS	TOP
1	552201	Fasano	Cisternino	12	368,2	44,9	1,6	00:46:20	11	3	11	9	4	8	5	5	14	8
2	553745	Bitritto Puglia	Bitonto	15	81	26,7	2	00:42:00	14	1	1	3	4	3	3	5	5	6
3	555252	TRIGGIANO	Carbonara	3,3	41	15,4	0,835	00:41:00	8	1	2	13	14	10	1	3	10	11
4	555512	Laterza	Laterza	6,6	350	48,4	4,3	00:40:00	7	1	1	11	8	3	1	10	7	1
5	566879	Lucera	Lucera	5	192	19,8	2,82	00:26:00	1	1	4	2	1	1	4	4	3	2
6	566927	Rocchetta S.A. (FG)	Rocchetta	1,6	596	76	1,02	00:12:04	12	1	6	6	3	7	2	4	9	4
7	567428	Altamura	Altamura	6	388	23,4	0,8	00:29:00	1	2	2	5	1	4	1	14	1	2
8	567559	Foggia	Siponto	32	1	3	2,31	00:37:00	7	1	3	2	7	13	5	8	4	10
9	567604	Foggia	Segezia	14	134	208	2	00:45:12	3	1	3	5	6	4	9	11	1	7
10	567637	Martina Franca	Chiancaro	1,5	397	423	2,9	00:51:39	14	2	1	10	3	13	1	3	1	9
11	567658	Manfredonia	Amendola	18	34	39	0,617	00:41:00	1	2	14	9	1	11	2	13	11	5
12	567719	Troia	Troia	0,6	1	1	2,29	00:30:00	1	1	1	5	1	1	2	12	1	5
13	567876	Lucera(FG)	Lucera	5	126	30,4	3,42	00:20:33	11	1	5	11	1	1	8	14	2	6
14	570501	Bari	Torre a mare	12	1	4	1,06	00:13:21	4	1	3	3	1	30	3	11	6	7
15	570643	Foggia	Ordona	17	91	9	1,73	00:36:00	1	1	1	1	1	1	1	4	4	3
16	580072	Colletorto (CB)	Colletorto	0,8	571	775	7,9	01:28:49	8	1	5	1	8	12	8	5	8	6

Fig. 3 The collected database (features are described through the citation frequencies of relevant words in the notes)

The internet portal of the experimental session, with personal details as well as relevant directions and information for respondents, is reported in Fig. 5. As said above, the specific objective of this work is to analyze the possible dependence of spatial sensations and perceptions from other physical and relational elements characterizing an open space. In this framework the statistical analysis method of multiple regression analysis was used as a pilot methodological experiment.

That method was not selected just to formally single out an algorithmic law of dependence of sensations on the various characters emerging along an open-space route. Rather, multiple regression allows to investigate on the possible correlations, relations of mutual dependence among variables, focusing on multiple independent variables at the same time. By using this approach, it is possible to aim at making a thorough and mutually comparative evaluation and discussion, which is necessary because of the small sample analyzed

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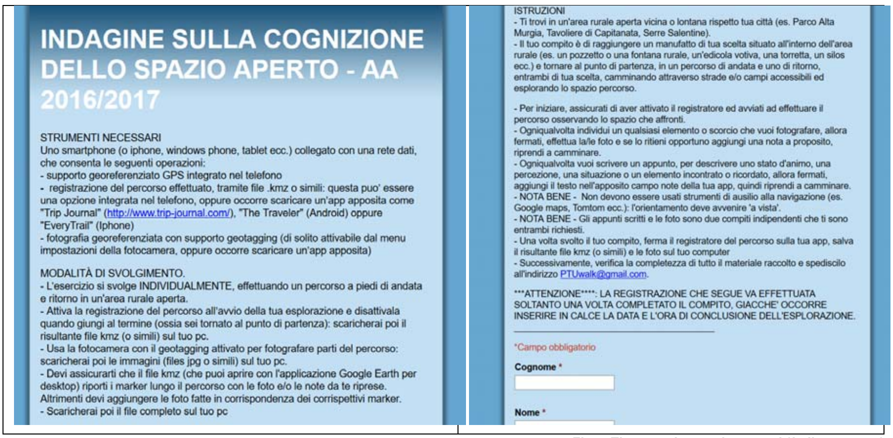
(Cohen et al., 2014, p.84). The multiple regression was carried out using the data analysis plug-in of Microsoft Excel, and statistical results are summarized in Fig. 6.

Buildings	**COS**	EDILIZIA, BORGO, MASSERIA, CASALE, COSTRUZIONE, URBANI, CONVENTO, FONTANA, PIETRA, PONTE, CHIESA, EDIFICIO, MURETTI, SILOS, TORRE, VILLA, ABBEVERATOIO, ABITATO, CASA, DEPOSITO, FRANTOIO, PAESE, PORTA, POZZO, TORRI, TRULLO, ARCO, ARCO, CAPANNI, CASTELLO, FINESTRE, MANUFATTO, MARMOREE, MONASTERO, SCALA
Fauna	**FAU**	CAVALLI, INSETTI, ANIMALI, CANI, COLEOTTERO, DOG, FAUNA, VIPERA
Flora	**FLO**	VEGETAZIONE, ALBERI, PIANTA, FLORA, CIPOLLE, ERBA, FICO, FIORE, FRONDE, MORE, POMODORI, VERDURE
Natural landscape	**PAE**	CAMPO, GRANO, RURALE, COLTIVAZIONI, TERRA, ULIVI, VIGNA, CAMPAGNA, TORRENTE, VALLE, AMBIENTALE, AMBIENTE, FLUVIALE, INCOLTO, NATURA, PAESAGGIO, AGRICOLO, AGRUMETO, BUCOLICO, FIUMETTO, PARCO, RACCOLTO, ACQUA, AMBIENTE, ARATURA, CANNETO, FILARI, MONTI, PARK, STEPPA, STERPAGLIA
Dissipation and pollution	**INQ**	RIFIUTI, DEGRADO, ABUSIVISMO, AMIANTO, ECOMOSTRO
Sensations	**SEN**	ABBAIARE, ABBANDONO, ACCIDENTATO, ACRE, AGEVOLE, APPARIVA, ARIA, ARSO, BELLO, BENESSERE, BREVE, BRUCIATA, CALDO, CALMA, COGNITIVA, COLORI, COMODO, CONFONDE, CONTRASTO, DETURPA, DISMISURA, DISSESTATO, DISTESA, EFFETTO, ESALAZIONI, ESPLORARE, FATICA, GRADEVOLE, IMMAGINE, LIBERTÀ, LUCE, ODORE, ORIENTARMI, PACE, PANORAMA, PERICOLANTE, PERICOLO, PIACEVOLE, RISTORO, RUMORE, SCORCIO, SCORGERE, SECCO, SENSAZIONE, SENSO, SGRADEVOLE, SICUREZZA, SPENSIERATEZZA, SPERANZA, STANCHEZZA, SUGGESTIVO, TORRIDO, TRANQUILLITÀ, VENTICELLO
Plants and installations	**TRA**	INDUSTRIALE, PALE, EOLICO, ARTIGIANALE, RECINTO, CANCELLO, ACQUEDOTTO, AZIENDA, DIGA, TRATTORE, ANTENNA, PALI, PANNELLI, PISCINA, TRALICCI
Streets	**VIE**	STRADA, PERCORSO, SENTIERO, ATTRAVERSARE, TRAGITTO, ASFALTO, CAMMINO, STERRATO, RAGGIUNGERE, SEGUIRE, PASSEGGIATA, SALITA, BIVIO, FERROVIA, INCROCIO, SVOLTA, CURVA, RETTILINEO, TRACCIATO, TRAFFICATA, VIAGGIO
Abstract features	**ABS**	VISTA, FORTUNA, INCOMPIUTI, PRESENZA, TRADIZIONI, IGNOTO, NATURA, QUALITÀ, VISTE, ASSENZA, ANTICO, PROSPETTIVA, OBIETTIVO, ILLUMINAZIONE, INTERNO, PARTI, STATO, TEMPO, APERTO, LONTANANZA,
topology	**TOP**	CONFINI, LUOGO, POSTO, RECINTO, TERRITORIO, SPAZIO, INGRESSO, INTORNO, LATO, AREA, ORIZZONTE, PUGLIESE, CIGLIO, LUOGHI, PUNTO, QUI, PARTE, TERRENI

Fig. 4 Legend of the aggregated variables (*Italian excerpt*)



INDAGINE SULLA COGNIZIONE DELLO SPAZIO APERTO - AA 2016/2017

STRUMENTI NECESSARI
Uno smartphone (o iphone, windows phone, tablet ecc.) collegato con una rete dati, che consenta le seguenti operazioni:
- supporto georeferenziato GPS integrato nel telefono
- registrazione del percorso effettuato, tramite file .kmz o simili: questa puo' essere una opzione integrata nel telefono, oppure occorre scaricare un'app apposita come "Trip Journal" (http://www.trip-journal.com/), "The Traveler" (Android) oppure "EveryTrail" (Iphone)
- fotografia georeferenziata con supporto geotagging (di solito attivabile dal menu impostazioni della fotocamera, oppure occorre scaricare un'app apposita)

MODALITÀ DI SVOLGIMENTO.
- L'esercizio si svolge INDIVIDUALMENTE, effettuando un percorso a piedi di andata e ritorno in un'area rurale aperta.
- Attiva la registrazione del percorso all'avvio della tua esplorazione e disattivala quando giungi al termine (ossia sei tornato al punto di partenza): scaricherai poi il risultante file kmz (o simili) sul tuo pc.
- Usa la fotocamera con il geotagging attivato per fotografare parti del percorso: scaricherai poi le immagini (files jpg o simili) sul tuo pc.
- Devi assicurarti che il file kmz (che puoi aprire con l'applicazione Google Earth per desktop) riporti i marker lungo il percorso con le foto e/o le note da te riprese. Altrimenti devi aggiungere le foto fatte in corrispondenza dei corrispettivi marker.
- Scaricherai poi il file completo sul tuo pc

ISTRUZIONI
- Ti trovi in un'area rurale aperta vicina o lontana rispetto tua città (es. Parco Alta Murgia, Tavoliere di Capitanata, Serre Salentine).
- Il tuo compito è di raggiungere un manufatto di tua scelta situato all'interno dell'area rurale (es. un pozzetto o una fontana rurale, un'edicola votiva, una torretta, un silos ecc.) e tornare al punto di partenza, in un percorso di andata e uno di ritorno, entrambi di tua scelta, camminando attraverso strade e/o campi accessibili ed esplorando lo spazio percorso.

- Per iniziare, assicurati di aver attivato il registratore ed avviati ad effettuare il percorso osservando lo spazio che affronti.
- Ogniqualvolta individui un qualsiasi elemento o scorcio che vuoi fotografare, allora fermati, effettua la/le foto e se lo ritieni opportuno aggiungi una nota a proposito, riprendi a camminare.
- Ogniqualvolta vuoi scrivere un appunto, per descrivere uno stato d'animo, una percezione, una situazione o un elemento incontrato o ricordato, allora fermati, aggiungi il testo nell'apposito campo note della tua app, quindi riprendi a camminare.
- NOTA BENE - Non devono essere usati strumenti di ausilio alla navigazione (es. Google maps, Tomtom ecc.): l'orientamento deve avvenire 'a vista'.
- NOTA BENE - Gli appunti scritti e le foto sono due compiti indipendenti che ti sono entrambi richiesti.
- Una volta svolto il tuo compito, ferma il registratore del percorso sulla tua app, salva il risultante file kmz (o simili) e le foto sul tuo computer
- Successivamente, verifica la completezza di tutto il materiale raccolto e spediscilo all'indirizzo PTUwalk@gmail.com.

ATTENZIONE*: LA REGISTRAZIONE CHE SEGUE VA EFFETTUATA SOLTANTO UNA VOLTA COMPLETATO IL COMPITO, GIACCHE' OCCORRE INSERIRE IN CALCE LA DATA E L'ORA DI CONCLUSIONE DELL'ESPLORAZIONE.

*Campo obbligatorio

Cognome *

Nome *

Fig. 5 The experimentation portal (*Italian excerpt*)

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Regression Statistics	
Multiple R	0,999991784
R Square	0,999983569
Adjusted R Square	0,999753529
Standard Error	0,117466051
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	14	839,7362017	59,98115727	4347,00461	0,01188717
Residual	1	0,013798273	0,013798273		
Total	15	839,75			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	25,02714273	0,333871773	74,9603434	0,00849225
LUO	0,269964976	0,006949165	38,8485468	0,0163836
ALT	-0,06864833	0,000777872	-88,2514665	0,00721339
DIS	0,126104067	0,000905269	139,3000343	0,00457006
LUN	1,17971297	0,043601742	27,0565561	0,02351852
TEM	-1,32767152	0,01004726	-132,142648	0,00481758
COS	0,522506398	0,017177803	30,41753346	0,02092183
FAU	19,31984334	0,209791355	92,09075045	0,00691269
FLO	-0,71345684	0,029718375	-24,0072629	0,02650248
PAE	-1,32845931	0,023628667	-56,2223559	0,01132206
INQ	2,703984806	0,043864162	61,64451045	0,01032637
TRA	-0,87958957	0,022028729	-39,9292017	0,01594038
VIE	0,556696904	0,011979752	46,46981903	0,01369753
ABS	1,412044889	0,024395856	57,88052263	0,01099777
TOP	-1,73927257	0,04533949	-38,3610974	0,01659169

Fig. 6 The multiple regression analysis output

$$\begin{aligned} Y_{SEN} = 25{,}02 + 0.27X_{LUO} - 0.06X_{ALT} + 0.126X_{DIS} + 1.179X_{LUN} - 1.32X_{TEM} + 0.52X_{COS} \\ + 19.31X_{FAU} - 0.71X_{FLO} - 1.33X_{PAE} + 2.70X_{INQ} - 0.88X_{TRA} + 0.56X_{VIE} \\ + 1.41X_{ABS} - 1.73X_{TOP} \end{aligned}$$

From the statistical analysis of the database, which resulted in the above regression equation, some considerations of a certain interest emerge. Obviously, the small sample implies that just large trends and suggestions can be drawn out, not robust interpretations. Furthermore, notwithstanding the general significance acquired (R2> 0.99), many regression coefficients are rather low and show little actual correlation in absolute terms. First, it is noted that the expression of sensations and perceptions during navigation increases in relation to the quantitative variation of some features. In particular, the expression of sensations increases with pollution and dissipation of resources appearing in the route (INQ: coeff.= +2.70; p= 0.01). It also strongly increases in relation to the presence of animals (FAU: coeff.= +19.31; p= 0.007), probably due to their emerging as unexpected singularities along the route. Sensations show mixed correlations with built and artificial features, made possible by the above mentioned fluctuation of coefficients around zero value.
For example, agents' sensations increase with the perception of buildings (c= 0.52, p= 0.02) and streets (c=0.55; p=0.01), while decreasing with plants and installations (c= -0.88; p= 0.01). This may look somehow curious and substantially inconsistent. Yet perhaps the nature of the sample should be considered here, being made up entirely of engineering students of a planning course, who learn to evaluate buildings and roads as contextual parts of a larger ecological environment. They may tend to overestimate their perceptions of transformations in which they have a design responsibility (e.g., houses, farms, streets) while underestimating

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the perception of elements out of their direct design interest (plants, installations etc.) (Borri & Camarda, 2006; Selicato et al., 2012). As a matter of facts, such underestimation does not seem to affect contextual value judgements, such as the dissipation or pollution involved with physical transformations, since sensations are positively correlated with dissipating or polluting elements, as shown above. Another curious result is the significantly negative correlation with the perception of natural landscape (c= -1.33, p= 0.01). This may look somehow counterintuitive and difficult to interpret. However, some literature suggests that the perception of usual environments may not be very relevant by agents whose life, activity, dynamics continuatively occur in that environment (Kelly & McNamara, 2010; Lipinski et al., 2010). Natural landscapes are common environments for agents (students with their families) living in regions and lands still largely, traditionally characterized by agriculture and rural features. Therefore, they may be able and willing to depict landscapes even deeply, as they know them rather well, without being impressed in terms of sensations. The contrary may hold too, as agents may be stimulated to express sensations, emotions without describing their perceptions about a landscape inherently known (Campos et al., 2012; Gantar & Golobič, 2015). As a matter of facts, the flora component (c= -0.71, p= 0.03) seem to broadly confirm such interpretation.

Then there are elements that define the exercise from a spatial-temporal, geographic and topographical point of view. For example, when the distance from the agent's place of residence (c= 0.26, p= 0.02) and particularly route length (c= 1.18, p= 0.02) increase, then sensation increase -being probably due (respectively) to curiosity about a new environment and to a more changing environment. Yet, a negative correlation with the time required to cover the route (c= -1.33, p= 0,005) seems to be inconsistent with that, unless one considers that a longer time can induce a sort of addiction to perceptions, particularly if the route is short and not very varied (Kelly & McNamara, 2010; Weinreb & Rofè, 2013). However, the sensations seem to be in general barely correlated to the perception of dimensional and topographical aspects, while appearing more correlated to contextual and qualifying elements.

4 CONCLUSIONS

The analysis carried out above shows outcomes of a certain suggestion, formally significant in statistical terms, less significant in substantial terms at least in some cases. This is mainly due to the limited number of observations, which determines an overall status of a pilot study, not a proper research. From this point of view, in fact, there are many coefficients with low numerical value, so that the investigated variables have little influence on the dependent variable - i.e., the agent's spatial sensations and perceptions along the route (SEN). Furthermore, concerning the aggregation of textual concepts by categories, it has been developed with a raw and hybrid approach that has possibly determined errors. In fact, while the word frequency has been collected through data-mining tools, it has been subsequently contextualized and categorized manually by the analyst through ex post analysis. However, after carrying out the whole analysis, it was still possible to derive interesting qualitative considerations. In fact, they seem to suggest that the perception of an open space, largely devoid of the strongly structuring elements present in confined urban spaces, still depends on some recurrent physical and landscape elements that end up giving it a cognition based latent structure. The use of these suggestions can be particularly interesting to support decisions regarding the management of open spaces, their valorisation during the identification processes of physical and/or identity resources for hypothesis of environmentally sustainable development of settlements, as well as for land use planning purposes.

At the present stage, some follow-up activities seem to be important to be carried out in the next future. They will particularly aim at giving greater robustness and reliability to the analysis and develop more aware and useful considerations. First, an enlargement of the analysis to the entire sample of 180 observations will be

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an indispensable and significant step. Secondly, attempts will be made to integrate the statistical analysis with probabilistic inference techniques, in order to compensate statistical errors induced by the multiple regression tool.

As a perspective follow up, the survey carried out here will be subsequently complemented by ontological aggregative approaches, as increasing emerging in spatial cognition literature (Barkowsky et al., 2007). This effort is oriented to investigate the possible realization of formal models more suitable to replicate and/or to interpret the complexity of the relevant environmental system.

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AGENT-BASED MODELLING AND GEOGRAPHIC INFORMATION SYSTEM

FOR EVALUATION OF ECO-DISTRICT'S SCENARIOS

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ABSTRACT

Nowadays, urban regeneration processes increasingly face energy issues. The European Union has recently adopted some directives for promoting energy redevelopment and diffusion of almost zero energy buildings at a large-scale with a view to post-carbon cities. However, to achieve a sustainable growth, the reduction of the greenhouse gas and energy consumption is not sufficient. A wide range of problem dimensions must be investigated and considered, such as social, economic and environmental aspects.
In this multidimensional context, to investigate the stakeholders' role and to understand their objectives and desires is essential not only to achieve consensus among parties but also to increase planners' capabilities in solving decision problems. In this context, the agent-based model (ABM) is of interest to urban planners and municipalities, thanks to its bottom-up approach. The possibility to observe the agent's (individual actors) actions come from the interactions among them in a specific environment is particularly important to address the sustainable and long-term vision of a city. To those aspects is added the necessity to link this simulation model with spatial and temporal analysis, to create a real world of investigation. The use of GIS and its linkage with ABM seems particularly effective to achieve the final goal. The case study investigates potentials and limits coming from the integration of the two methods in the evaluation of different scenarios with the aim to realize an eco-district in the heart of Turin (Italy). The objective of the research is to use the San Salvario neighbourhood as a test-bed for an upgrading of the overall city sustainability.

KEYWORDS

Urban Planning; Agent-based Model; Geographic Information System; Energy

1 INTRODUCTION

Nowadays, there is an intensive debate about the reduction of Green House Gas (GHG) emission, the decrease in energy consumption and the transition to renewable energy. Many are the directives adopted by the European Union for promoting energy redevelopment with a large-scale view of post-carbon cities. As a direct consequence, cities have started to define future strategies and plans to achieve these goals. In that context, the retrofitting of buildings is strictly important for their highest amount of energy usage in our cities. However, the retrofitting strategies are not sufficient unless they are considered in a larger view of development, in which all the pillars of sustainability should be considered. In fact, the energy transition must be a part of a vision concerning the experimentation of urban policies able to face new challenges in the social and environmental transformations governance of a city or a part of it. It is thus clear that apart from the investigation of all multidimensional aspects, it is necessary to pass from the analysis of a single building to an analysis at the district/neighbourhood level, following those models of sustainable energy transition generally called "eco-districts" or "sustainable neighbourhoods". Although these terms refer to a very broad array of concepts, the literature review has underlined some principles to be taken into account for a sustainable urban development, such as satisfaction of human needs, considering neighbourhood impact on the wider environment, providing compact development and integrated sustainable mobility and developing harmonized coupled human-environment system (Luederitz et al., 2013).

The picture that emerges is of an area of investigation extremely complex, in which policymakers must take decisions often not so clear as a first approximation. For that reason, over the years, different evaluation approaches and techniques, from the most consolidated (such as SWOT, Costs Benefits or Multicriteria analysis) to the innovative ones (such as Choice Experiments or Fuzzy analysis), have been developed to face the complexity of decision-making problems in urban areas. An interesting research path concerns the so-called Mixed Methods, that combine qualitative approaches typical of social sciences with quantitative ones based on mathematical models and statistical analysis.

An innovative and powerful analytic and computational method recently emerged is the Agent-Based Model (ABM). This approach offers a flexible architecture able to realize a detailed representation of complex agent systems, including the behaviour of agents, their social interactions and the environments that surround them (Khansari et al., 2017).

In a certain way, also these methods do not consider a fundamental element related to the urban complex problems, namely the real spatial nature of urban and territorial problems. Therefore, the objective of our research is combined this innovative approach (ABM) through Geographic Information Systems (GIS) capable to synthetize geographic information and data.

The case study investigates potentials and limits coming from the integration of the two methods in the evaluation of different scenarios of sustainable development with the aim to realize an eco-district in the heart of Turin (Italy). The objective of the present paper is to frame a methodological proposal for the application of the integrated ABM-GIS model. The real case study of the San Salvario neighbourhood in Turin will be considered for the experimentation.

2 AGENT-BASED MODEL (ABM)

In the present section, a brief description of the ABM methodology is proposed, coupled with an analysis of the relevant articles in the domain of urban planning.

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2.1 METHODOLOGICAL BACKGROUND

The Agent-Based Model (ABM) is a powerful method able to build complex systems starting from individual actors (called agents) whose coincident acting leads to emergent effects or outcomes (Hinker et al., 2017). These results do not come from the actions of a single agent, but the final effects of the interactions of all actors (Grimm et al., 2006). Simulating individual actions of many diverse agents and measuring the resulting system allows realizing a decision-making process really based on a bottom-up approach, in which the stakeholders act to achieve their own objectives and interests. Another element that characterizes this approach is the presence of a shared environment in which the agents interact. Connecting the environment with the all multidimensional aspects of the decision process can be a useful tool for study the effects on processes that operate at multiple scales and organizational levels (Brown, 2006). In more detail, it is possible to define three components as the key elements that characterize the ABM, namely *the agents*, *the interactions* and *the environment*. About *the agent*, the literature does not provide a univocal definition on his characteristics. However, Macal and North (2010) underline certain essential characteristics that the agents need to have:

- **autonomy** in its environment and in its interactions;
- **self-sufficiency, modularity, uniqueness and individual identifiability**[1];
- **a state** that varies over the time;
- **a social dynamic** that influences its behaviour through the interactions with other agents.

The interactions among agents are particularly important because they generate changing in agent behaviours. Primary issues of the modelling are to figure out whom agents are connected and the types of interactions' mechanisms. Related to the first aspect, not all agents interact with all the others, but with a subset of them: this group represents the neighbour of an agent. For the second aspect, exist many types of agent relations' modelling: with Cellular Automata (CA), in the 2D or 3D Euclidean Space, with Network topology, with Geographic Information System (GIS) and with the aspatial "Soup" model (Macal & North, 2010). *The environment* represents the place in which agents interact. It could have different information and detail levels: it may give only information about the agents' spatial location or a rich set of data, like a GIS.

2.2 LITERATURE REVIEW

The analysis of the literature has underlined different phenomena with respect to the theme of ABM. With the use of the database Scopus, we investigated all articles related to the Agent-Based Model (ABM). In that case, the documents resulted are more than 11 thousand, already written before the seventies, but with a significant increase after 2005. On the contrary, the publications related to the Agent-Based Model (ABM) and its application in urban and energy regeneration are considerably less of about 120 documents. All were written after 2000 and the considerable growth occurs after 2005 (Fig. 1). Considering only the documents that use an integration between ABM and GIS, the relevant articles passed from 118 to 5. In-depth analysis underlines two relevant aspects: first, exist in addition to agent-based model (ABM) the so-called multi-agent systems (MAS), normally used for the separation of logical components of intelligent systems (Hinker et al., 2017); second, the scale of the project is in most cases an urban scale and so, less indicated to analyse district regeneration and transformation. The ABM seems to be very useful to define land use in relation to the

[1] These characteristics allow to clearly define the boundaries of each agent.

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behaviour of the agents considered. An exception is represented by the Hinker et al. (2016) research, that uses the ABM for analysing socio-technical optimality gaps in the energy domain at a district level: both the project scale and type of agents involved are similar and comparable to our case study. The main papers consulted for our research are given in Tab. 1.

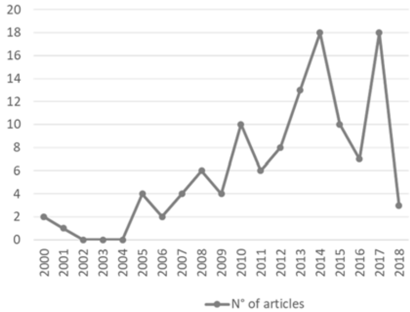

Fig. 1 Number of publications related to the Agent-Based Model (ABM) and urban-energy regeneration written over the years

AUTHORS	TITLE	DESCRIPTION	YEAR
Bush, J., Roelich, K., Bale, C.S.E. & Knoeri, C.	Scaling up local energy infrastructure; An agent-based model of the emergence of district heating networks	ABM; scenarios at district level	2017
Gaube, V. & Remesch, A.	Impact of urban planning on household's residential decisions: an agent-based simulation model for Vienna	ABM; urban level	2013
Heppenstall, A.J., Crooks, A.T., See, L.M. & Batty, M.	Agent-Based Models of Geographical Systems	ABM + GIS	2012
Hinker, J., Hemkendreis, C., Drewing, E., Marz, S., Hidalgo Rodriguez, D.I. & Myrzik, J.M.A.	A novel conceptual model facilitating the derivation of agent-based models for analysing socio-technical optimality gaps in the energy domain.	ABM/MAS; district level	2017
Hosseinali, F., Alesheikh, A.A. & Nourian, F.	Agent-based modelling of urban land-use development, case study: Simulating future scenarios of Qazvin city.	ABM; scenarios at urban level	2013
Khansari, N., Silverman, B.G., Du, Q. & Waldt, J.B.	An Agent-Based Decision Tool to Explore Urban Climate & Smart City Possibilities.	ABM + GIS; urban level	2017
Le, Q.B., Park, S.J. & Vlek, P.l.g.	Land Use Dynamic Simulator (LUDAS): A multi-agent system model for simulating spatiotemporal dynamics of coupled human-landscape system 2. Scenario-based application for impact assessment of land-use policies.	MAS; scenarios at region level	2010
Ligtenberg, A., Beulens, A., Kettenis, D., Bregt, A.K. & Wachowicz, M.	Simulating knowledge sharing in spatial planning: an agent-based approach.	MAS; scenarios at region level	2009
Liu, H., Silva, E.A. & Wang, Q.	Incorporating GIS data into an agent-based model to support planning. Policy-making for the development of creative industries	ABM + GIS; district level	2016
Macal, C.M. & North M.J.	Tutorial on agent-based modelling and simulation	ABM	2010
Tian, G., Ouyang, Y., Quan, Q. & Wu, J.	Simulating spatiotemporal dynamics of urbanization with multi-agent systems – A case study of Phoenix metropolitan region, USA.	MAS; scenarios at urban level	2011

Tab. 1 Main articles from literature review in the context of urban planning

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3 CASE STUDY

3.1 DESCRIPTION OF THE SAN SALVARIO NEIGHBORHOOD

Fig. 2 Location of the San Salvario neighbourhood in Turin

Fig. 3 The San Salvario neighbourhood

The case study is located in Turin and, in particular, in the San Salvario neighbourhood. This area is placed in a strategical location in the south-east of the city (Fig. 2) close to the city centre, the railway station of Porta Nuova and the Valentino park (Fig. 3). The neighbourhood has a population of about 36 thousand and an extension of about 2.2 sq.km. Although the local population has started to decline since 1995, the number of people who live in that area remains rather stable, thanks to the increasing number of young people, mainly students, and foreigners. However, most of the population is old (Fig. 4), as well as in many other parts of the city.

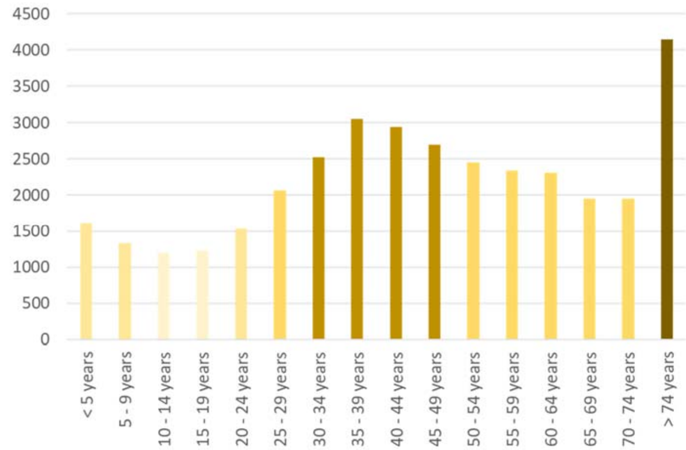

Fig. 4 Population graph of San Salvario (ISTAT data 2011)

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Of interest in our research was the analysis of the building stock of the neighbourhood to think about the retrofitting: as you can see in Fig. 5 the age of the buildings is quite diverse. The nineteenth-century buildings' quality has a considerable architectural value although the absence of ordinary and extraordinary maintenance has caused a significant degradation. Corso Vittorio Emanuele has many buildings with architectural value, while Via Nizza and Via Madama Cristina are characterized by public housing, craft activities, shops and clubs. Via Nizza is characterized by buildings with the C-shape, typical of the nineteenth century. Most of the buildings in Corso Marconi are characterized by the architectural typology known as "umbertina", dating back to the eighties of the nineteenth century. The most recent constructions are along the Valentino park and the area near Piazzetta Primo Levi.

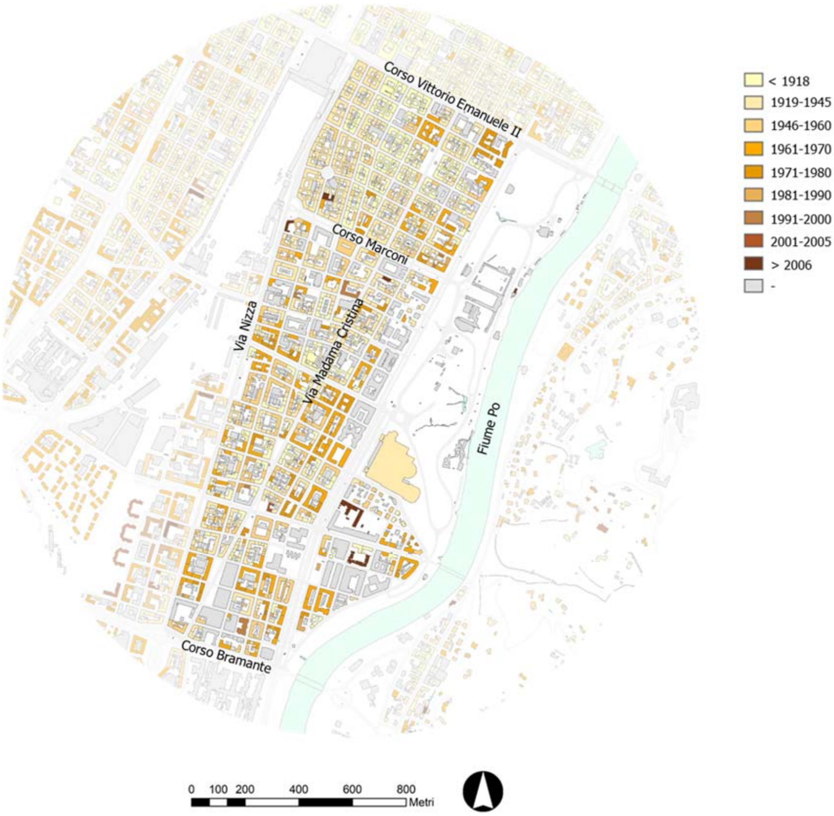

Fig. 5 Age construction of buildings (Geoportale of Turin GIS data 2017)

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3.2 STAKEHOLDERS ANALYSIS

The study of the area and of its peculiarities has underlined some relevant aspects to be considered. In respect to the very different people who live in the area and the many actors interested in this district management project, we have realized a stakeholder analysis. In order to understand what happened or what can happen in a decisional process, the first question that we have to ask is about who has contributed or could contribute to its development and outcome by adopting relevant behaviours (Dente, 2014). The power-interest stakeholders' analysis is one of the most used methods to understand the role of the different actors interested or called to the evaluation process. In particular, it allows to know in advance how we manage each of them: if the stakeholder has a low interest and power must be only monitored during the process; instead, if the interest increased they must be informed; on the contrary, if the interest is low but the power is high they must keep satisfied; finally, if both power and interest are high they must be managed closely. The Fig. 6 shows the stakeholders involved in the transformation process of San Salvario and highlighted their specific role.

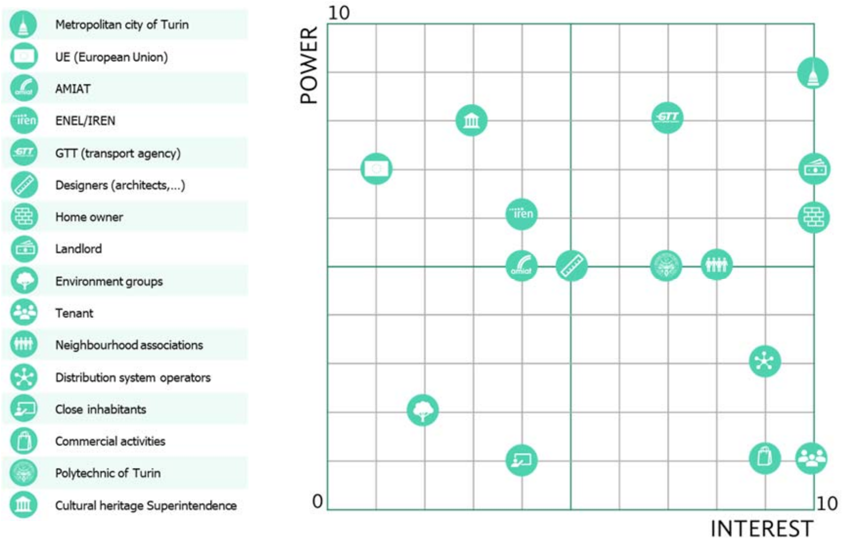

Fig. 6 Power-interest stakeholders analysis for the San Salvario district

4 PROPOSED EVALUATION PROCESS

According to the analysis of the literature developed in section 2, in order to face the difficulties for the application of ABM approach to complex environments, the problem of San Salvario district has been divided into different levels that were considered separately. Every single one represents the all aspects characterizing the eco-district model applied to San Salvario: (1) the retrofit of the building stock and the changing in the energy demand, (2) the improvement of mobility and (3) of recyclable waste collection, considering the social integration of the actual urban structures.

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4.1 OVERVIEW OF THE ABM FRAMEWORK

As described in the methodological background, the three main elements that characterized an agent-based model are the actors, the environment and the interactions. Following the scheme proposed by Hinker et al. (2017) for the application of the ABM approach, it is fundamental to define other aspects (described below) that represent the common framework for the creation of our model.

(1) Objective: represents the specific objective of each level of our ABM model, that, joined with the others, generates the overall aim of the research.

(2) Actor class: a general group of actors with similar intentions.

(3) Layer: represents the actor's field of action. In the first phase, the layers depend on the actor, ultimately, they are harmonised and unified.

(4) (Primary) intentions: in the real world each person has different and specific intentions, but, to reduce the complexity of the model, we have considered the most urgent ones, defined them as the primary intentions of the actor.

(5) Compulsions: with this term, we refer to the all external forces that can ban some actions of other actors. An example of a compulsion could be the presence of a law that inhibited an action.

4.2 EXAMPLES OF INTERACTING SYSTEMS

Starting from the keywords previously described and taking into account all the pillars of sustainability, we have built the structure of our ABM model. For each one of the considered levels for the transformation of the San Salvario district, specific objectives and related actors, layers, primary intentions and compulsions were defined to have a broader picture of the problem for the application of the ABM approach.

<u>Retrofit Of The Building Stock And The Changing In The Energy Demand</u>

A first relevant interaction among agents comes from the realisation of the first objective, i.e. the retrofit of the building stock and the changing in the energy demand. From one side, it creates effects on owner, landlords and tenants caused by the cost of intervention, the profit and the lowering of energy costs. From the other side, the project could generate gentrification phenomena and a change of the inhabitants' social target, that must be considered by the local authorities to avoid possible reactions by the neighbourhood's associations.

(1) CHANGING IN ENERGY DEMAND (economic aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Homeowner	Building stock and power grid	Ensuring climate comfort	Limited financial possibility: public administration must support with economic programs the refurbishment
Landlord		Increasing profit	Having a return on the investment
Tenant		Reducing energy expenses	Low economic status

(2) MAINTAIN/REDEVELOPMENT URBAN STRUCTURES (social aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Municipality	Entire district	To incentive building retrofitting, considering the social status of the inhabitants	Limited financial resources Gentrification phenomena

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(3) OPERATIONS ON THE ENERGY INFRASTRUCTURES (technical aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Distributor system operators (including ENEL/IREN)	Power grid and energetic systems	Diffusion of their specific energy strategy and knowledge	Achieving a post carbon district

(4) CHANGING IN THE QUALITY OF LIFE (environmental aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Inhabitants (neighbourhood associations and close inhabitants)	Entire city	Reduction of CO2 emissions	The realization of the redevelopment project

Improvement of district mobility

The creation of a district characterized by the presence of different alternative means of transport, it is a great opportunity for the inhabitants and in particular for the neighbourhood residents. However, the success of this intervention depends on the intents and the possibilities of both the municipality and the Turin transport agency (GTT).

(1) CHANGING IN THE MOBILITY DEMAND (economic aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Neighbourhood residents (Homeowners and tenants)	Entire city	Reduction mobility expenses	A limited number of public means of transport

(2) INCREASE OF ALTERNATIVE MOBILITY (social aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Municipality	Entire city	Radical change in trade of actual mobility use in favour of the diffusion of alternative means of transport	Limited financial resources

(3) DIFFUSION OF ALTERNATIVE MEANS OF TRANSPORT (technical aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
GTT (transport agency)	Entire city	Increasing the number of people that use its service	Limited financial resources

(4) CHANGING IN THE QUALITY OF LIFE (environmental aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Inhabitants	Entire city	Reduction of CO2 emissions	The realization of the redevelopment project

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Recyclable waste collection

One of the pillars of the Turin municipality's last policies is the diffusion at a larger scale of the recyclable waste collection. An improvement of the actual way could be texted in this area and, then, spread to the overall city. In that context, the municipality and the waste agency have the responsibility to inform the inhabitants and to acquire the knowledge necessary for the success of the entire project.

(1) CHANGING IN THE RECYCLING WASTE COLLECTION (economic aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Neighbourhood residents	Entire city	Reduction in waste expenses	The comprehension of the roles of recycling waste collection

(2) REDUCTION OF THE QUANTITY OF WASTE (social and environmental aspects)

ACTORS OR CLASS	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
Municipality/Inhabitants	Entire city	Reduction of the quantity of waste, increasing the recyclable one	Limited public financial resources

(3) IMPROVEMENT OF THE RECYCLABLE WASTE COLLECTION (technical aspects)

	LAYERS	PRIMARY INTENTIONS	COMPULSIONS
AMIAT (waste agency)	Entire district	Efficiency in the collection of recyclable waste	Limited financial resources and knowledge of the Turin waste agency

5 DISCUSSION OF THE PRELIMINARY RESULTS AND FUTURE STEPS

In this paper, a methodological framework was conducted to better apply the integration between the ABM and GIS to the specific case study of San Salvario. To facilitate the structure of our model, we have used the so-called ODD (Overview, Design concepts, and Details) protocol, developed by Grimm in 2006 and implemented in 2010. Based on the ODD, we started to draft the so-called "overview", that represents the first macro-step of the protocol. However, the complexity of our case study and the multi-dimensions to be considered has caused the necessity to form a more extensive conceptual model.

For the future steps of the analysis, we will develop the other phases of the ODD, i.e. design concepts and the detailed analysis. In fact, once the model has been conceptualised, it must be formalised into a specification which can be developed into a computer programme. In this sense, a more in-depth analysis is also necessary to decide into the variety of existing software the most appropriate one for the development of our model. In addition, we would like to join to the ABM toolkit the functionality offered by the GIS software libraries to add greater data management and spatial analytical capabilities for the geospatial modelling.

To this end, it is possible to affirm that the proposed approach seems to be particularly useful for structuring the complexity of the decision problem under investigation, as it offers a bottom-up interactive solution to the more traditional aggregated modelling approaches (Chen, 2012).

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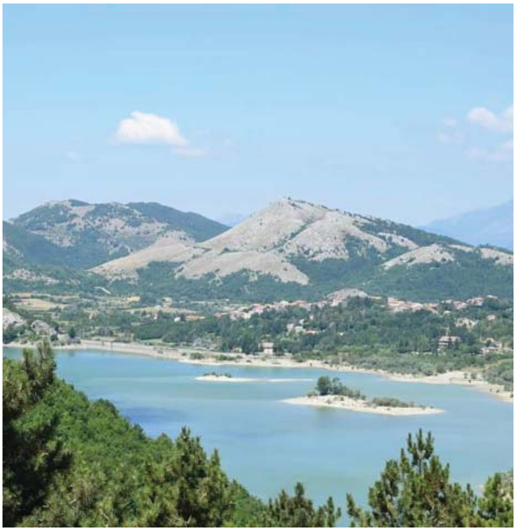

LAND DEVELOPMENT SUPPORT IN MARGINAL AREAS

AN OPPORTUNITY OF ENVIRONMENTAL QUALITY IMPLEMENTATION

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ABSTRACT

Most of the European territory cannot be understood as simply places with specific and defined spatial, functional and perceptive features. In this general view, marginal lands, "territories in between" (TiB), "less favoured areas" (LFA), are recognized as areas in transformation, in which particular attention should be paid in order to a coordinated development of whole territory. The aim of the study is to deepened knowledge these marginal in order to further a range of development opportunities starting from specific features. In Italian context, Molise Region has an important amount of internal, less-favoured areas, in order to its morphological structure and its historical and economic development. In this paper a comparison between LFAs and TiBs was developed, starting from their allocation and from OECD and European Commission definitions. Then, the Ecosystem Services (ES) were assessed through economic approach, comparing regional average with site-specific values. Results show general high ES values at regional level, compared to other Italian context. Al local level, ES assessment shows critical conditions within the TiB inside LFAs, with high ES values and economic disadvantage. The analysis shows, therefore, the importance of these areas as support to landscapes and habitats preservation; they are (and have to been considered) important parts of cultural and environmental heritage. Quantitative indices and parameters are useful tools to highlight, through objective and numerical terms, land criticisms but also opportunities. These aspects can involve public opinion and support decision-maker on conservation policies.

KEYWORDS

Marginal Lands; Ecosystem Services; Landscape Planning

1 INTRODUCTION

Areas characterized by a closed interaction between urban and rural functions, or with problems such as fragmentation, abandonment, pollution or with low level of productivity cannot be read as simply places with defined spatial, functional and perceptive features. Together with traditional "urban" and "rural" physical classifications of landscape, the more recent definitions of "middle landscape" or "hybrid geographies" were recently introduced, with connotations of areas needing for specific management and planning approaches, more related to their intrinsic characteristics and value. In this general point of view, marginal lands, "territories in between" (TiB) and less favoured areas (LFA), are recognized as areas in transformation, for which particular attention should be paid in order to get a coordinated development of whole territory. As a matter of fact, these areas are not simply rural places with intensification
n of urban functions. At the end of ’30s of the past century many studies deepened the problem of territorial classification (defining them as *zwischenstadt, tussenland, città diffusa, fringe areas*, etc.) according to the different areas of study.

Only since 70s these classifications affected concretely spatial planning policies (Frijters et al., 2004; Louis, 1936; Secchi, 1991; Wandl et al., 2014, 2017). Starting from EEC Directive 75/268, Less Favoured Areas (LFA) scheme allows individuating disadvantaged rural areas, responding to the widely divergent regional situation of EU agriculture, with respect to both the socio-economic situation and natural features (MacDonald et al., 2000). In areas designated as "less-favoured", agricultural production or activity is often more difficult because of natural handicaps, e.g. difficult climatic conditions, steep slopes in mountain areas, or low soil productivity in other less favoured areas.

On the other hand, the role of rural activities is very important, for the production, care and use of landscape, for the traditional social structures maintenance, as well as for a multifunctional basis for other economic sectors (Cialdea, 2000, 2005, 2012, 2017, 2018a , 2018b; Cialdea & Badami, 2017; Cialdea & Maccarone, 2012; Cialdea & Mastronardi, 2014a, 2014b, 2017a, 2017b; Cialdea et al., 2006; Ducci et al., 2017; Pindozzi et al., 2016). Recent studies recognize to these areas increasingly important opportunities in terms of sustainable and resilient development, because of biodiversity and richness of ecosystem services, green infrastructures and vocation to renewable energies production, etc. etc. and therefore become strategic areas for achieving sustainable land management. The use of Ecosystem Services (ESs) theory in a structured way into landscape planning, management and design, is changing the terms of discussion on nature conservation, natural resource management and other areas of public policy (Cervelli et al., 2016a; Pindozzi et al., 2013, 2017; Rigillo & Cervelli, 2014).

This study deals with the adoption of a framework mathematically based which entails two steps. Firstly, potential marginal areas identification has been carried out, starting from TiBs definition and LFAs perimeters, integrating development suitability with economic disadvantage. Secondly, ESs assessment, by means of monetary approach, has been performed.

The aims of the work are the following: to deepen knowledge of marginal areas in contexts that revealed economic disadvantages, despite of their high environmental, cultural and landscapes values, and to assess their current resources, in order to support potential land use change or intensity of use.

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2 MATERIALS AND METHODS

2.1 STUDY AREA

Study area, of about 4.400 km2 encompasses the whole Molise Region, consisting of two Provinces divided in 136 Municipalities, inside mountain areas (55.3%) and hilly areas (44.7%). Study area presents a high natural, environmental and cultural-historic value, highlighted by one Campania Regional Park (Matese Regional Park), twelve SCIs and four SPAs (Fig. 1), urban historic centers, natural trails for the herds passage called "tratturi" (Cialdea, 2004, 2007, 2013a, 2013b, 2015, 2017; Cialdea & Cacchione, 2013; Cialdea & Mastronardi, 2015). Nevertheless these resources are not transformed into opportunities for sustainable socio-economic development: the economy is poorly developed compared to other Italian regions, despite the region shows an index of per capita GDP higher than other Southern regions.

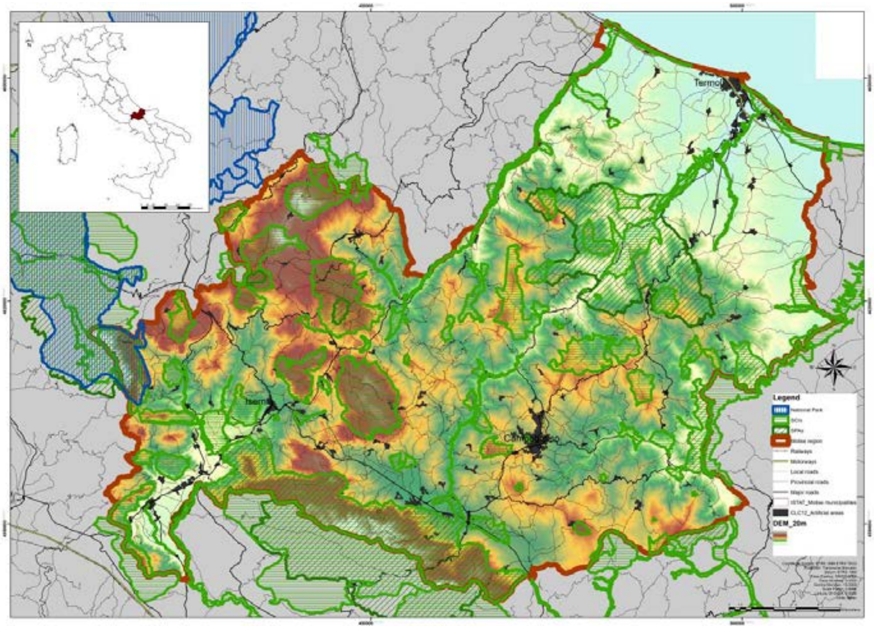

Fig. 1 Study area which shows: artificial surfaces, mobility network, heights and natural protected areas system (Source: our elaboration, 2018)

The main economic driving force is the primary sector, with a total of about 34,000 companies and 9,600 workers, equal to about 8% of the total regional workers (twice than the national average level), depending on a strongly established agricultural tradition. In line with this data, the primary sector still absorbs substantial percentage of the labour force, although not as much as in the past. The secondary economic sector is present in the industrial centres of Termoli (on the coast), Campobasso-Bojano, Campobasso-Ripalimosani and Venafro-Pozzilli (internal areas). The natural environment is a source of attraction, particularly in the seaside centers (Termoli, Campomarino, Montenero di Bisaccia, Petacciato) and

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mountainous recreation areas (Campitello Matese, Capracotta, National Park of Abruzzo, Lazio and Molise), but not adequately exploited (the region is last for tourist arrivals).
The demographic trend of the population living in Molise, from 2001 to 2016, shows a decrease of 3.1%, with a strongly negative migration balance (-22%, in 2016) mainly due to the cancellation of residents because of their moving to other municipalities, and with an equally negative natural balance, due to the reduction of births (-20% in the last 15 years).
The identification of potentially marginal areas can therefore constitute a strategic element to support decision makers, for the definition of policies for sustainable development, capable of safeguarding the local people rights about land management (depending on their socio-economic development instances, starting from local opportunities and resources) and, at the same time, capable of preserving environmental values.

2.2 MARGINAL AREAS IDENTIFICATION

According to different EU documents and scientific community in the field of landscape and urban planning (Dijkstra & Poelman, 2012; Lewis & Hugo, 2012; Wandl et al., 2014, 2017), marginal lands into the study area were processed by means of different steps: 1. Detection of any "urban centre" with high-density population (as grid cells layer); 2. Identification of their commuting zone; 3.
Integration with LFAs. As first reference the methodology reported by Dijkstra and Poelman (2012), allowed identifying areas without a specific self-sufficiency, integrating data on the resident and present population from census data (ISTAT, 2011), with economic presence, communication infrastructures and economic indicators, such as commuting. All grid cells with a density of more than 1500 inhabitants per km^2 were selected, starting from Corine Land Cover 2012 (CLC12) map and the above mentioned census data; were used. Thus the contiguous high-density cells are then clustered obtaining the Urban Audit city boundaries. In this way it was possible to identify urban areas with more than 50,000 inhabitants. Then, all the municipalities (local administrative involved in the Urban Centre) with at least the half part of their population falling inside the urban centre were selected as candidates to become part of the city.
Once cities have been defined, commuting zones were identified. Commuting zones correspond to areas in development, no urban and no rural, with uncertain relationship between policies and spatial development, in terms of housing, economic activities, mobility, social relations, trough the following steps.
Adding artificial surfaces (except urban fabric) from Corine Land Cover 2012 and mobility infrastructures (buffer 500m), and subtracting the continuous urban fabric (CLC12), "Territories in between" were defined in each commuting zone. The *territories in between* sorted out were then compared and integrated with the LFAs, defined by Axis 2 of Rural Development Policy for 2007-2013. In Italian context, Molise Region has an important amount of internal, less-favoured areas, due to its morphological structure and its historical and economic development. As defined in Dir. 75/268/EEC, LFAs include mountain areas, other disadvantaged areas, defined as areas threatened with depopulation and areas where natural environment conservation is necessary, and finally, areas where specific disadvantages occur. In the following we refer to LFAs development by comparison between institutional disadvantages (as stated by Dir. 75/268/EEC) and simulated disadvantage (CAIRE, 2010).

2.3 ECOSYSTEM SERVICES

Ecosystem services have been defined as the benefits human derive from nature (natural capital) through a set of ecosystem functions (MEA, 2005). The natural capital of a context constitutes the basis of social

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welfare and sustainable development, so it is essential to know it and to evaluate it. Evaluating ES supply and demand can support long-term informed decisions, providing estimates of costs and benefits associated with decisions and scenarios. Beyond differences in definitions reported in various reference documents (Haines-Young & Potschin, 2013; MEA, 2003, 2005; TEEB, 2012) the ES are generally classified in provisioning, cultural, regulation and maintenance, etc. There are various types of assessment, this study referred to the monetary value because of the regional level of the study. Namely this approach allows to quantify the ecosystem value expressed by the landscape, also considering different scenarios, through a monetary index, objective and comparable (Cervelli et al., 2016b, 2017). In land-use planning and management, the use of monetary ESs allows taking decisions selecting the choice with "greater value" (Cervelli et al., 2016b).

Each ES monetary valuation is unavoidably affected by errors (real existence of a market, willingness to pay, use / non-use value, etc.) and/or uncertainties (number of variables in complex systems, etc.). Nevertheless, ES assessment in monetary terms allows explicit inclusion, in the definition of strategies and choices between expected costs and benefits, being an useful indicator for reporting environmental issues (Schirpke et al., 2014). There are numerous formulas for economic evaluation of environmental assets that can be distinguished by type of value or component of the Total Economic Value. In this paper, starting from Scolozzi (Scolozzi et al., 2012), the value of ES_i for each land use polygon is calculated following

Eq. (1): $VES_{i,k} = A_k * w_i(LC, dist) * v_i(LC)$

Where:

$VES_{i,k}$ is the value (€/year) of i-ES for k-polygon of a defined land use,

A_k is the k-polygon area,

w_i is a coefficient for i-ES and specific LC considering context variables.

v_i is the monetary value of i-ES for defined LC (€/ha).

Specifically, the monetary values were obtained from Scolozzi's study and update. Corine Land cover 2012 map was used for land cover classes and as basis to obtain distance from urban areas.

3. RESULTS

3.1 REMARKS FOR MARGINAL AREAS IDENTIFICATION

As first result, the *Territories in between* map allowed identifying the high density centres (in Molise region), the urban Audit Cities and their commuting zones, covering multiple municipalities. The high density urban centres are seventeen (17/136), with almost the half part of their population inside the urban centre. The first Urban Audit City perimeter, including the whole administrative areas of each high density centre; extends for about 1000 km^2, corresponding to 20% of the Molise region. The percentage of commuters on the total population confirmed the first perimeter.

The definitive commuting zones have included the enclaves-municipalities; six distinct commuting zones have emerged (Termoli on the easth-coast, Campobasso, Isernia, Bajano, Frosolone, Poggio Sannita, on the west internal areas), which cover a total of 1200 km^2 and include the main regional industrial centers. The maximum population calculation, compared with literature values, allowed identifying 43 km^2, in which maximum population density (including resident population and employees) is between 150 and 5000 inhabitants/km^2. Starting from land use dataset and infrastructure network, TiB were defined in the six commuting zone, equal to 525 km^2, 12% of the whole regional area (Fig. 2). In addition, TiB included in LFAs were processed, intersecting morphological and economical data. Excluding 12 municipalities (near sea

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cost), all Molise region is included in LFA. The new perimeter for TiBs in LFA and CM, extends for about 1700 km^2, 38% of total regional area (Fig. 3). TiBs are suitable for agricultural uses (1000 km^2), followed by natural and semi-natural areas (600 km^2), artificial, wetland and water bodies (78 km^2). The arable lands are the 70% of agricultural areas.

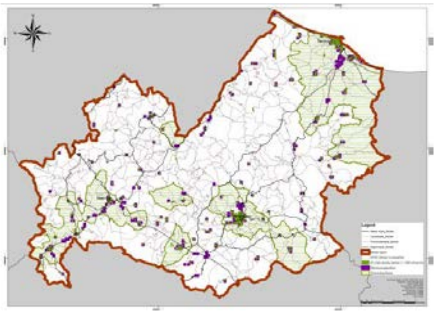

Fig. 2: Maximum population and Commuting zones (Source: our elaboration, 2018)

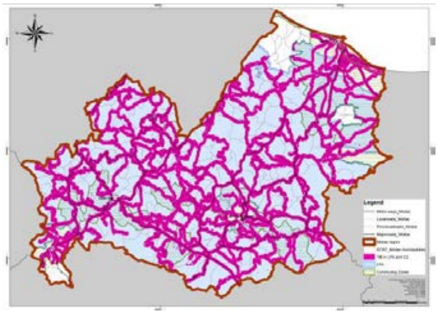

Fig. 3: TiB in Commuting Zones and Less Favoured Areas (Source: our elaboration, 2018)

3.2 REMARKS FOR ECOSYSTEM SERVICES

The total ES value of the whole Molise region is equal to 344M€, 775€/ha.

The map of ES values distribution (Fig. 4) on study area shows the specific value of each cell (20*20) and allows identifying areas with higher ES monetary values, in Molise region, namely: National Park of Abruzzo Lazio and Molise, areas closed to Campania Regional Park of Matese. On the other hand, inside these areas is possible to recognize some spot areas with the lowest ES values. The comparison of this map with the natural protected areas, underlines the congruence of the values. A specific analysis was made into TiB inside Commuting zones and LFAs. Values are reported in Tab. 1.

VARIABLES	AREA (sq. km)	ES TOTAL MONETARY VALUE (M€)	ES MEAN MONETARY VALUE (€/ha)
Molise region	4437	344.02	775.34
TiB in LFAs	1506	107.27	712.28
TiB in CZ	525	25.75	490.48

Tab. 1: ES monetary value (Source: our elaboration, 2018)

Es monetary values for TiB in CZ are the lowest. LUC class analysis shows how the lower ES values per hectares are associated to classes 211-Non-irrigate arable land and 311-Broad leaved forest, because of their huge areas; however in the CZs ESs values are the half compared to the value for the same classes, in LFA areas.

4 DISCUSSIONS AND CONCLUSIONS

The Molise region has a high naturalistic and environmental value that could also become a source of important tourism-economic development.

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The identification of priority action areas can become strategic, in order to preserve the actual resources, and, at the same time, to improve local economy. In this paper the TiBs inside the commuting zones are identified as areas undergoing possible transformation because of demographic, logistic (infrastructures), socio-economic (employment, commuting) reasons.

They were then integrated with possible TiBs in LFAs, in order to include also lands with disadvantaged economic situation, in contrast with their high environmental values. Priority action areas constitute 35% of the whole regional surface.

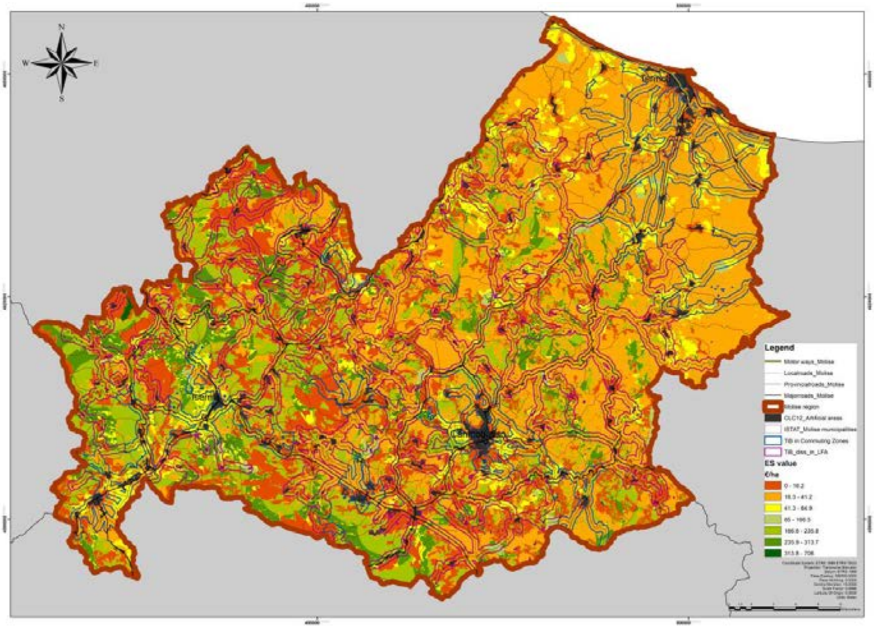

Fig. 4: ES values distribution (Source: our elaboration, 2018)

The ES monetary values assessment was performed, at the meta-data level and it is based on literature values, both for whole region and for priority areas. Results showed an important role of priority action areas (in terms of weakness or resource) and they support policies in which nature conservation and conservation management do not necessary pose a trade-off between the environment and development (de Groot et al., 2010). Multicriteria assessment frameworks, taking into account different landscape aspects (TiBs and LFAs, in this study), can contribute to a sustainable ecosystem use, identifying contexts more strategic, able to generate substantial ecological, social, and economic benefits.

The proposed integrated approach is aimed to improve knowledge and awareness about the strategic choices at policy level and to facility institutional/public communication, in order to achieve a real implementation of planning policies arising from a shared and transparent analysis process.

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LANDSCAPE URBANISM'S INTERPRETATIVE MODELS

A NEW VISION FOR THE TIBER RIVER

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ABSTRACT

Our proposal identifies the River Contract as a process to implement the urban public spaces through the redevelopment of the Tiber River as a natural infrastructure. The River Contract is a participatory process with operational implications for the redevelopment of river basins. The state of art of the River Contract in Italy has been analyzed. Our sample area is located in the Roma Province, along the Tiber River in the area from Fara Sabina to Castel Giubileo. This particular area is actually not covered by any Contract, although there are a lot of naturalistic elements and boundary conditions that could lead to a good success and unexpected implications of this new instrument, oriented not only to naturalistic engineering, but also to urban design. Values of this actually not covered area have been highlighted through some different landscapes urbanism's categories: Waterscapes that include the Tiber River and other tributaries; Naturalscapes that include some Regional Natural Reserves and the "Laghetti in Località Semblera" Natural Monument and finally the Regional Natural Park of Veio; Ruralscapes that involve all rural zones, including areas related to CREA (Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria) and CNR laboratories; Culturalscapes as archaeological areas, castles and ancient buildings, museums and ancient mills; Infrastructuralscapes that involve Salaria, Tiberina, Flaminia, Nomentana Roman Consular Roads and local railways. The aim of our investigation, supported by territorial georeferenced analyses, is the Regeneration Strategy for the Tiber River to connect all these Values, related to different "Scapes" for the new "urban" dimension.

KEYWORDS

Public Space; River Contract; Urban/Territorial Dimension

1 INTRODUCTION

Our dissertation investigates the relationship between the plurality of factors that insist on the river landscape. This approach can still be more significant in a context of Inner Areas, such as geographical areas subject to strong centrifugal forces, with demographic problems and unstable development, but endowed with resources that are lacking with the large centers of agglomeration, with strong attraction potential. Furthermore, Inner Areas can be the basis for the study of polycentric solutions aimed at improving the production quality. In order to optimize the relationship between cities and countryside, they can accept models of development linked to forms of valorization of the natural and cultural heritage and to the maintenance of their territorial identities. The River Contract tool (RC), voluntary negotiated and participatory programming agreement, may be an opportunity for achieving the landscape quality aims foreseen by our National Code for Cultural and Landscape Heritage of 2004, as amended and supplemented (Repubblica Italiana, 2004). River Contracts make the principles of protection of the landscaping plan their own, both under the profile of its naturalistic and environmental relevance, as well as artificial landscape, man's work (Cialdea 2017b; Cialdea & Cacucci, 2017), as it has been described in the National River Contracts Charter of 2010 and defined by the National River Contracts Table (Tavolo Nazionale dei Contratti di Fiume 2010). The River Contract presents itself, in the light of these considerations, as a new opportunity to affect the development potential of Inner Areas. It can become the driving element of a new vitality for these places, as a territorial management tool that starts from the bottom, and therefore from the needs and desires of people who live on the territory (Cialdea & Quercio, 2017; Corrado, 2014; Minervin, 2014). Many national and international studies address the matter of the relationship between planning tools and the river landscape (Bianchini, 2014; Esposito, 2014; Ingaramo & Voghera, 2016) and they are also more and more the subject of specific studies for graduate (Ciuffreda, 2017; Pompei, 2018) and PhD (Morri, 2017) thesis. Therefore, the RC potential lies precisely in its capacity to concretize operations destined to overcome the greatest challenges in the territorial and environmental field. It can become a catalyst to promote the implementation of district planning tools, in favour of better management of water resources and more efficient use of agriculture (Servadei, 2015) and, at the same time, to improve integrated actions related to the vast area planning. In several investigated cases, which are increasingly involving national and international territories, opportunities to promote practical actions for the development of the most disadvantaged territories through this tool are focused (Bastiani, 2011), with policies destined to Inner Areas and also to vulnerable environments as is the case of waterways enclosed in wetlands. Our project is related to the completion of the River Contract network of the Tiber River. The aim is to connect and make efficient the Tiber network from the point of view of the landscape management, from Umbertide to the river mouth, in order to create a "public use" network. To do this, it was elaborated the new proposal of the "Middle-Low Tiber River" Contract, in the stretch that goes from Fara Sabina to Castel Giubileo, in the Lazio Region in a part all included within the Province of Rome. This Inner Area is the only stretch uncovered by the River Contract of the Tiber River and that generates a break and a separation between the "Tevere umbro" (Tiber River along the Umbria Region) and the "Tevere romano" (Tiber River along the Rome area), thus losing the discourse of protection and valorization of river and landscape continuity. The project, in line with the current orientation of the territorial and landscape management, intends to remedy this separation. A reference RC planning model has only existed a few years, thanks to the push, the commitment and the researches carried out by the National River Contracts Table, born specifically in 2007 as working group of the Italian Local Coordination A21, with the objective to create a community able to exchange experiences

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and promote river contracts in Italy. Because of this, in the legislative field, different laws aid to structure RC themes and process ensuring RCs planning status, from the European level to the regional one (in our case-study the Lazio Region). At European level there are several directives related to the water framework safety. The first one is the Habitats Directive 92/43/EEC, that means "Safeguarding biodiversity through the conservation of natural habitats and wildlife in the European territory of the Member States to which the treaty applies" (European Commission, 1992). Then the Water Framework Directive 2000/60/EC has been elaborated to prevent qualitative and quantitative deterioration, to improve water status and ensure sustainable use, based on the long-term protection of available water resources (European Parliament and Council, 2000). The Flood risk Directive 2007/60/EC references to the identification of flood and risk areas, in accordance with common criteria and for the assessment and management of flood risks (European Parliament and Council, 2007). At the national level, in Italy, we find the already mentioned Legislative Decree No. 42/2004 which defines the principal environmental safeguard measures, as well as the Law No. 14/2006 (Repubblica Italiana, 2006a). In order to attend the European directives, the D. Lgs 152/2006_art. 68bis establishes national reference measure in the field of environmental impact assessment, soil defence and water protection, waste management, reduction of air pollution and compensation for environmental damage (Repubblica Italiana, 2006b). With the same aim, according to the European Flood Risk Directive, the national D. Lgs 49/2010 pursues on the assessment and management of flood risks. In the last few years, after several Italian river flooding, the need of common rules to preside over the river basins lead to define the above mentioned National River Contracts Charter which describes the River Contracts as "a process of negotiated and participatory programming aimed at the containment of eco-landscape degradation and the redevelopment of the territories of basins and hydrographic sub-basins" (Repubblica Italiana, 2010). Furthermore, the Law No. 221 (Repubblica Italiana, 2015) identifies RCs as "voluntary instruments of strategic planning and negotiation that pursue the protection, the correct management of water resources and the valorization of the river territories, together with the safeguard from the hydraulic risk, contributing to the local development of these areas, which contribute to the definition and implementation of district planning tools at the basin and watershed level" (art.43bis). Finally, thanks to the basic quality definitions and requirements of the River Contracts (Tavolo Nazionale dei Contratti di fiume, 2015), the RCs has been defined as a support of the planning and/or action. At regional level the Resolution No. 42 (Regione Lazio, 2007) and the Resolution No. 787 (Regione Lazio, 2014) pursue the maintenance of the integrity of the water resource, compatibly with the uses of the resource itself and the socio-economic activities of Lazio people. They contain necessary measures for the qualitative and quantitative protection of river basins, in addition to the interventions aimed at ensuring the achievement and maintenance of the water system. Analyzing the current laws, River Contracts are intended, firstly, to help overcome the logic of the emergency to create, whereas, a synergy between urban, rural and natural context, integrating tangible and intangible actions for culture, quality of life, landscape and economy. The primary objective is to define environments related to water courses as 'living landscapes' (Jønch-Clausen & Fugl, 2001), so that they can be perceived and governed as such also into the urban dimension.

2 THE TERRITORIAL CONTEST

Our study area, of about 400 km^2, runs for 23 Km from Fara Sabina to Castel Giubileo, but the analyzed river section is long about 40 Km. It includes 10 municipalities in the Province of Rome. The most important element is the Tiber River, which is perceived only as a negative element, because of its floods at the expense of urban living. In this regard, the little town of Monterotondo turns out to be the most affected,

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presenting many critical issues. The proposal of the Middle-Low Tiber RC takes start, as for other cases in Italy, from the need of hydraulic safety. In this particular case, there is the need to restore relations that existed in the past (former brick kilns) and to bring the river back to its role of public space and "Itinerary of water and communication" (Provincia di Roma, 2010), now completely lost, but living in remembrance. A role that crosses and continues the relationship "history, culture and nature". The elements most in view, such as the agricultural areas along the irrigated valley of the Tiber, are the predominant character of the area and they have an important role for the production, care and use of landscape, for the traditional social structures maintenance, as well as for a multifunctional basis for other economic sectors (Cialdea, 2000, 2012, 2017a, 2018; Cialdea & Badami, 2017; Cialdea & Maccarone, 2012; Cialdea & Mastronardi, 2014a and 2014b, 2017a and 2017b; Cialdea et al., 2006; Ducci et al., 2017; Pindozzi et al., 2016).

Then there are the industrial areas that are located close to the Tiber, its valley and the highway (Riano, Fiano Romano, Capena, Monterotondo, Montelibretti villages) and several protected areas. Other elements that are not valued are the research institutes of CREA and CNR and the recreation areas-Tiber Extreme Park, Salaria Sport Village, Lago La Barcaccia, CONI-Riano Sport Centre - which would instead bring the decisive impetus to safeguard the environment and the health of populations, favouring its careful utilization, but also to create the possibility to recover old paths, that can be restored as greenways to slow mobility and historical buildings along them can be used by a sustainable tourism (Cialdea, 2018; Cialdea & Cacucci, 2017). The project is based on the valorization of all these values and this new network will be related to the other Tiber RCs stretches (Fig. 1) and recreational areas in terms of relapses on the urban environment:

- the section from Umbertide- Città di Castello is covered by the Alta Umbria RC (2008) and it is characterized by some attractive elements: the Corbara Lake and the Alviano Lake, 500 hectares of humid environment that is a naturalistic oasis. This final stretch of the Tiber River in the Umbria Region, of about 50 km, constitutes the Tiber River Park. Several interventions and bike tracks were made in safety of the embankments (Umbertide);
- the stretch from Città di Castello to Orte is characterized by the increase of the flow, after the confluence with the tributary Chiascio, the one with the Paglia River and especially after the confluence with the Nera River. Here we find the Paglia RC (2013), which at the height of Orvieto has allowed the creation of a river urban park and the Nera RC (2010), which aims to the valorization of the natural and historical environment;
- the section Orte-Fara Sabina is covered by the Medium Valley Tiber RC (2012). Here the Tiber River receives the abundant waters of the Nera-Velino watercourses and borders Tuscia and Sabina, where the Treja, Amella first and the Farfa then flow in, alternating with ravines and sheltered areas. There is the "Fiasco" that you can admire from the alluvial terraces. Here we find the Treja Valley Regional Park and The Nazzano Natural Regional Reserve;
- the stretch from Castel Giubileo to the Tiber mouth is covered by the proposal of the Tiber RC in the urban area of Rome (2017). In this area there are strong interaction between urban and natural textures. In addition, the river area is included as one of the strategic programming areas of the Rome Urban Master Plan. Tiber River receives the Aniene River for which the RC (2018) has been proposed.

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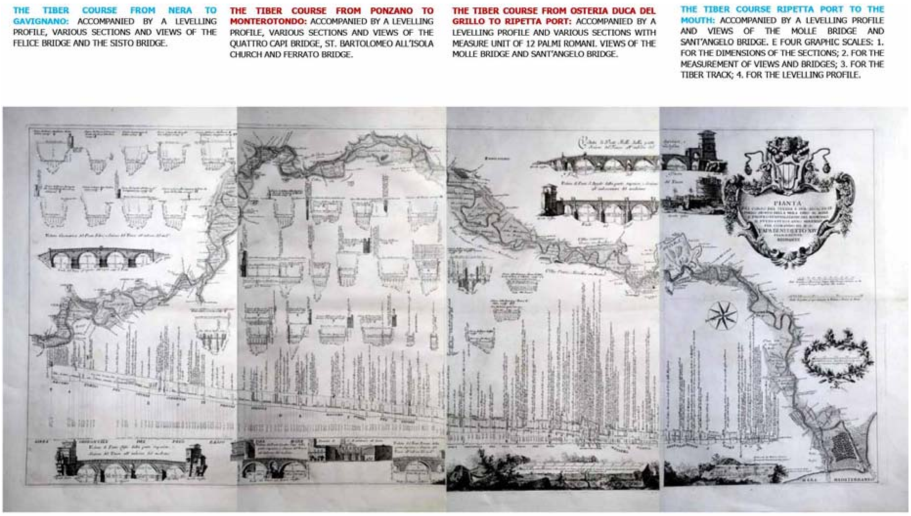

Fig. 1 The stretches of the Tiber River from Nera tributary to the mouth (Source: Pianta del corso del Fiume Tevere, e sue adiacenze, dall'influenza del Nera fino al mare e profilo di livellazione il tutto fatto l'anno MDCCXLIV per comando di N.S. Papa Benedetto XIV felicemente regnante. Chiesa A., Gambarini B., Nolli C., Piranesi G.B. Roma, 1744)

3 THE INTERPRETATIVE PROCESS MODEL

In order to create and develop a reference model (Fig. 2) and to define a project that fits perfectly in the RCs puzzle in continuity of analytical and design logic, able to enhance all the values identified, our proposal has highlighted common tools, characteristics and peculiarities, actions and results of Tiber RCs.

All the already implemented Tiber RCs have in common the training modalities of the process itself: which starts from the identification of the intervention area. Then there is the strategic agenda with the maps of actors, values, interests, projects, tools and resources. Then the process establishes aims and actions of the multidisciplinary relationships with actors. Everything is always discussed, spotted and shared on an active participation and dialogue of institutions, associations and citizens. The innovative feature of these processes is the choice to go in the direction of the horizontal subsidiarity because of the multi-sector, inter-scalar and multi-actor strategies that generate development, trying to take the environment and landscape as the basis on which to rebuild the quality of territory. Thus, the differentiation of territorial systems requires a system of flexible governance, capable of composing conflicts and interests at local level through negotiation processes, adhering to territorial vocations and able to make system by communicating the different programming tools of socio-economic interventions with those of territorial planning.

4 APPLICATION THE CASE STUDY AND RESULTS

Our project has been oriented to relate the cognitive analyses of the territorial context and the RCs common procedures, elaborating the maps of Values, Interests, Resources and Actors. The maps of Values, Interests and Resources (Fig. 3) have been articulated in the logic of the landscape urbanism networks, for which is always more evident that the new urban question is stronger and stronger related to the environmental safeguard and the re-signification of environmental elements for the urban project and its new urban

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habitability to recycle the city through the water, the soil, the energy, blue and green networks (Gasparrini, 2015).

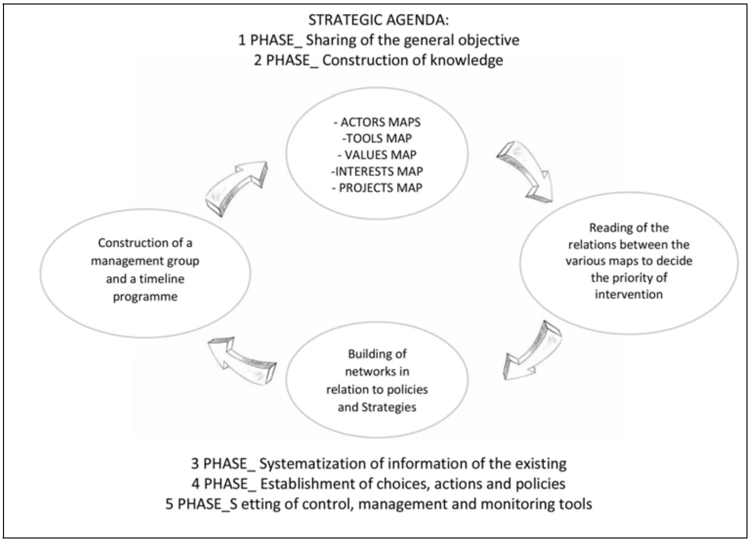

Fig. 2 The phases for the River Contracts development (Source: our elaboration, 2017)

They are:

- *the Water Network.* It provides the securing of the banks and embankments- especially in the section of Monterotondo Scalo-and the construction of docks for small boats, bridges connecting the two banks, works of re-naturalization, nature trails along the embankment. Moreover, it is hypothesized to restore the navigability of the Tiber River for this stretch, at least with small boats for the connection between the "Nazzano Tevere-Farfa" Regional Natural Reserve and the "Laghetti" Natural Monument in Monterotondo;
- *the Protected Areas Network.* It includes the connection through pedestrian and naturalistic paths of the various reserves of the area, as the "Macchia di Gattaceca e Macchia del Barco" Regional Natural Reserve, the "Marcigliana" Regional Natural Reserve, the "Nomentum" Regional Natural Reserve, the "Laghetti" Natural Monument, the "Nazzano Tevere-Farf"a Regional Natural Reserve and the "Veio" Regional Park;
- *the Strategic Areas Network.* All the research centres of CREA and CNR Laboratories and the industrial areas present in the territory are located. An internal connection to these centres is envisaged, almost to create a diffuse scientific park, as well as foresees the Provincial Plan of Rome in this area;
- *the Culture and Recreation Areas Network.* This one intends to relate historical and architectural buildings creating a territorial museum network (Museums of Riano, Fiano Romano, Monterotondo, Mentana, Montelibretti), through integrated pedestrian pathways to public and private transport. Moreover, it provides the connection of the territorial sport centres of Riano, of Monterotondo and of Castel Giubileo;

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- *the Waste Areas Network.* The study area is characterized by disused and abandoned areas and former quarries. particularly the Monterotondo Scalo former brick kilns and the Riano quarries. These constitute a strong degradation element, but at the same time a great opportunity for retraining, thanks to their historical testimony- within the urban or in the midst of protected environmental systems;
- *the Agricultural Areas Network*. In the area, there are three predominant landscapes. The irrigated countryside landscape that is located in the Tiber Valley. The urbanized countryside landscape that is grafted in the municipal territory of Monterotondo, Mentana and Fontenuova and it presents a strong interaction between agrarian and urban matrix. This is a peculiarity of the place to be protected and valued. Then there is the rolling hills landscape which encloses ploughed fields, olive groves, orchards in large or medium sized meshes;
- *the Infrastructure Network*. In this case, it is necessary to strengthen the railway line, the stations and the consular routes. The railway assumes a very important character: being a public transport, it allows to relate quickly the various points of interest in a direct way with the possibility to be integrated with the public motor-transport.

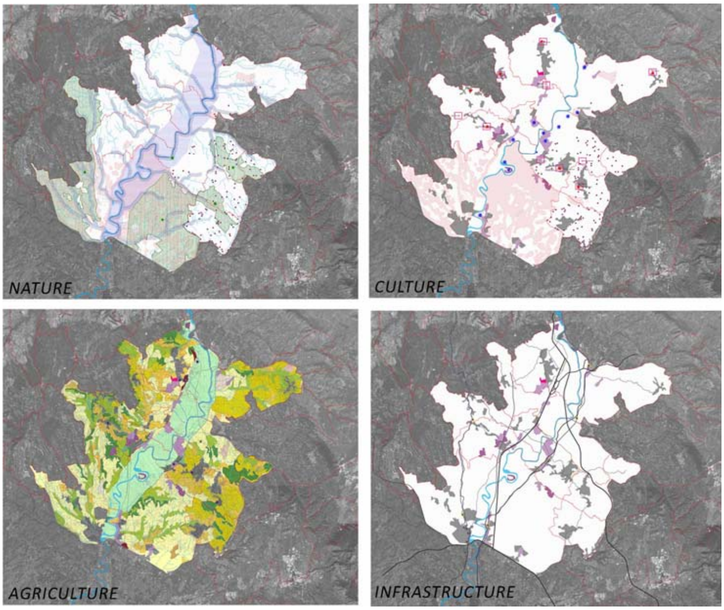

Fig. 3 The Nature, Culture, Agriculture and Infrastructure Categories (Source: our elaboration, 2017)

Thus, it had been possible to elaborate a map which represents the Masterplan of the Middle-Low Tiber River Contract (Fig. 4), where there are also our proposals for strategic local actions or suggestions for the projects to apply. The Actors' Map has been drawn up as a list of potentially involved subjects, to be questioned about their interest in the RC's implementation. They are the municipalities of Monterotondo, Fara Sabina, Riano, Fiano Romano, Castelnuovo di Porto, Montelibretti, Capena, Mentana, Fontenuova, III-

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IV Municipi di Roma, the Tiber River Basin Authority, the Institute for Technologies Applied to Cultural Heritage (ITABC), MiBACT, the Archaeological Trust of Lazio and Southern Etruria, The Regional Natural Reserve of the Macchia di Gattaceca and Macchia del Barco, the Regional Natural Reserve of Marcigliana and the RomaNatura Regional Association, the Regional Natural Reserve of Nomentum, the Regional Natural Park of Veio, the Sabina by bike Association, the Tiber Extreme Park, the Monterotondo cultural associations, the Archeoclub d'italia-section Mentana-Monterotondo. The Tools and Resources' Map establishes the RCs guidelines to be integrated with intervention programmes for local-scale projects. Consequently, the resources must be considered from time to time in relation to the local scale implication of public, private and entrepreneurial or community subjects.

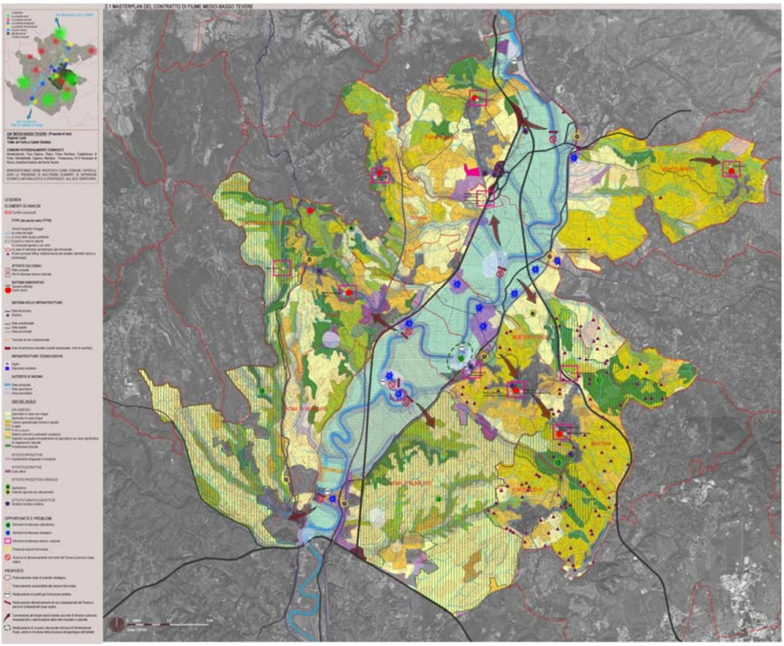

Fig. 4 The Masterplan of the proposed Middle-Low Tiber River Contract (Source: our elaboration, 2017)

5 CONCLUDING REMARKS

The strategy is to connect all the identified territorial values through the Tiber infrastructure, the Via Salaria and the railway. The Middle-Low Tiber River Contract assumes the dimension of Landscape Contract and that finds in each municipality its most complete and complex realization, that is the form of "urban" dimension. Actually, our proposal has defined the systematization of territorial data of values and interests (Tab. 1) elaborated through the territorial analyses. The data have been articulated by three macro-areas: Category, Network and Element, from the general group to the single point. Each one includes a classification of the environment through different level, according to the Italian legislative planning levels and the landscape set of features.

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CATEGORY	NETWORK	ELEMENT
NATURE	**Water network**	Tiber River
		Tributaries
	Protected areas network	Macchia di Gattaceca and Macchia del Barco Regional Natural Reserve
		Marcigliana Regional Natural Reserve
		Nomentum Regional Natural Reserve
		Laghetti in località Semblera Natural Monument
		Veio Regional Park
		Valle del Treja Regional Park
		Nazzano Tevere/Farfa Regional Natural Reserve
HISTORY AND CULTURE	**Culture network**	Locus Feroniae archaeological area
		Eretum archaeological area
		Monterotondo old town
		Mentana old town
		Fiano Romano old town
		Montelibretti old town
		Riano old town
		Monterotondo historical museum
		Monterotondo multimedial museum
		Mentana Garibaldian museum
		Montelibretti museum
		Ancient via Francigena
		Mills and farmhouses
		Castelli e palazzi storici
	Strategic areas network	CNR Monterotondo Institute
		CNR Montelibretti Institute
		Riano civil protection
		Montelibretti Fireman school
		CREA Monterotondo Institute
		Railway station
		Monterotondo Industrial area
		Capena Industrial area
	Recreation areas network	Extreme Tevere Park
		Barcaccia lake
		CONI Riano
		Salaria Sport Village
	Waste areas network	Monterotondo ex brick kilns
		Santa Colomba ex brik kilns
		Ficarone ex brick kilns
		Riano quarries
		Riano abandoned area
AGRICULTURE AND RURAL	**Irrigated countryside landscape**	Tiber valley
	Rolling hills landscape	Monterotondo area
		Roma-Fonte Nuova area
	Urbanized countyside landscape	Monterotondo countryside
		Mentana countryside
		Fonte Nuova countryside
		Montelibretti countryside
INFRASTRUCTURE	**Railway network**	Fiumicino Orte (FR1)
		Roma-Viterbo
	Road network	Consular road Salaria
		Consular road Nomentana
		Consular road Tiberina
		Consular road Flaminia
		A1
	Pedestrian network	Monterotondo
		Riano

Tab. 1 Systematization of the territorial data, by categories, networks and elements. (Source: our elaboration, 2017)

They are the basis for the realization of an evaluation system so to understand and identify the priorities of intervention. These are in development and they have as evaluation criterion a cross-reading of the interests of the stakeholders involved for each element.

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The same evaluation can be further articulated, establishing for each element the possible scenarios, according to the existing regulations or the proposals made by the stakeholders themselves: each stakeholder can express his own degree of interest for each scenario. Finally, merging data we could define the optimal scenario.

This process can also be done by simulation in laboratory, with the role play, but it is obvious that it lends itself much better to the application in reality. It represents a full aid for the systematization of the data in the "Partecipatory Perspective" of the River Contracts. So, at the time it was built a cognitive framework both of the criticalities and the environmental and landscape-territorial values, and of the local policies founding the strategies of intervention.

The completion of the project requires to activate a working table with the participation of the involved actors to accomplish the next steps of the medium-term strategic scenarios definition, the evaluation protocol processing, the integrated management and action programmes proposal and the training, communication and education plans application.

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THE LAND OF THE BORDER

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ABSTRACT

The present study is designed by starting from a critical observation of all those places at the margins. These spaces are considered 'space among things', space that unites and at the same time divides and in the present scenario they escape from any definition although their existence is certain as well as the political-territorial importance. The time of partitioning, 'matchings' 'overlapping' exists. We could say then that 'space among things', borders generally turn out to be places where antinomies take on a concrete form that conquer Space, becoming characteristic places, peculiar binding places and at the same time elements of separation, closure and even openness toward the stranger. On the other hand, crossing the border does not imply elimination of it but rather its momentary transformation in open space, used, organized and abandoned. Living the 'space in the middle' means, living and building a third place whose center is within, where everything is confused, mixed, where it is difficult to distinguish what belongs on one side and what belongs to the other. The hypothesis then, is space redefinition, another form or better yet, abandoning the common idea of barrier, the possibility to plan a flexible system, changeable and dynamic, a 'filter space', temporary, not continuous and fragmented within. The Land of the border becomes the Land where you are suspended in another dimension that ends up being a 'ridiculous passageway', where 'misunderstanding' dwells undisputed and very little is needed to have a conflict explode.

KEYWORDS

Globalization; Identity; Migration; Security; Territory; Walls

1 INTRODUCTION

According to Paul Valery, the time of the finished world has begun. Today we live in the era of partitioning, divisions, borders which testify mysterious, changeable realities, often inhabited by people 'on hold', by inspiring citizens, standing at the door, stuck in a parallel timeless world, far removed from any common definition and cognition. A world that declares to be a place of transition where a third space takes place, whose center is within, where everything gets confused, is mixed in a sort of return to the 'initial chaos', to a state with no primordial 'measure'. That's how the border lands are done, just so, 'spaces between things', spaces that unite and at the same time divide, spaces on the verge of exploding, that seem to have no definition accomplished, although their existence and importance are certain, since they have become increasingly 'lands of mirage', lands inhabited by people fleeing from war-torn countries, from the absolutist regimes, poor countries or victims that in some way use the conquered space in different ways and forms always oriented to favor a socio-political and cultural environmental change. Therefore, parallel to this multi-facet reality the following affirmation of a topography of globalization, theorized as the overcoming of a border topography which on the contrary faces a world without borders, in fact confined, agreeing with the boundless immaterial, with the virtual movement advertised everywhere but that in any case of border materialism, that is, in the building of walls, finds the walls of the modern short circuit before the modern era. We actually witness the global wall, multiplied, an inner overlapping of a political-legal system of walls built to protect or to 'conquer', concrete walls and barbed wire, hypertechnological walls or sand and bins, walls collapsing and others under construction. Walls that cut States, territories and entire populations, implied by the very idea of globalization that includes in itself, since in its etymology, the risk of its owns perversion: to raise a front against an enemy that does not threaten any war, a front that, in practice, is used to keep watch on another entity. The same Herman Melville described that same monomaniacal need to impose a line, in this case the fluidity of the sea, beyond which is better not to go, a wall that Captain Ahab in Moby Dick acknowledged: "For me, the white whale is that wall, it was pushed next to me. Sometimes I think that there is nothing beyond. But for me it's enough "(Melville, 1987). The Captain, in his fatal conceit, identified in the sea the field of vengeance, a contained reality, a game in which the rules and regulations had to be respected; a size that if declined to the current political and territorial scene always takes different forms and always the same, but in any case willing to confront and clash between multitudes of people 'travelling'. Globalization, in fact, does not supply the comparison between societies and cultures, on the contrary, it becomes tyrant in choosing just one, simple, predominantly Western one, which indeed, imposes itself with a universal claim that brings hyper production and continuous alienation of every material or immaterial aspect. It supports human odyssey, which could be imperative for survival, a challenge, a different way of life inclined to find the 'meaning' of the limit, the 'right fit' as demonstrated, geo-politically speaking from the widespread construction of walls and barriers that guarantee variety and discontinuity, of continuous changes and adaptations, certainly disinterested toward an absolutist approval or widespread standardization. Well then, why is it that today, the walls, starting from those among the States and those among the rich neighbourhoods and the rest of the city, end up being tangible proof of the failure of a culture and modern society? The reason is obvious since they have been building walls as of ancient and medieval times, while, in the first years of modern age, at a topographical-political level, the idea of borders were favored as a border in an area shared by two parties. Obviously, the wall as a definition is not a conquered frontier but one of defense, and it does not acknowledge both parties but only the right of one: the one inside. One particular case is the Berlin wall where the logic of border is more present. The German

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wall used to represent, in effect, a border even if not simply public, between two political and ideological orders which based their identity on contrast, taking one side or the other. Starting from the first wall erected in modern history we have had a world divided by barriers of barbed wire, or bricks and cement that testify just like the historic walls that they not only have not fallen but have increased after the Second World War (Fig. 1).

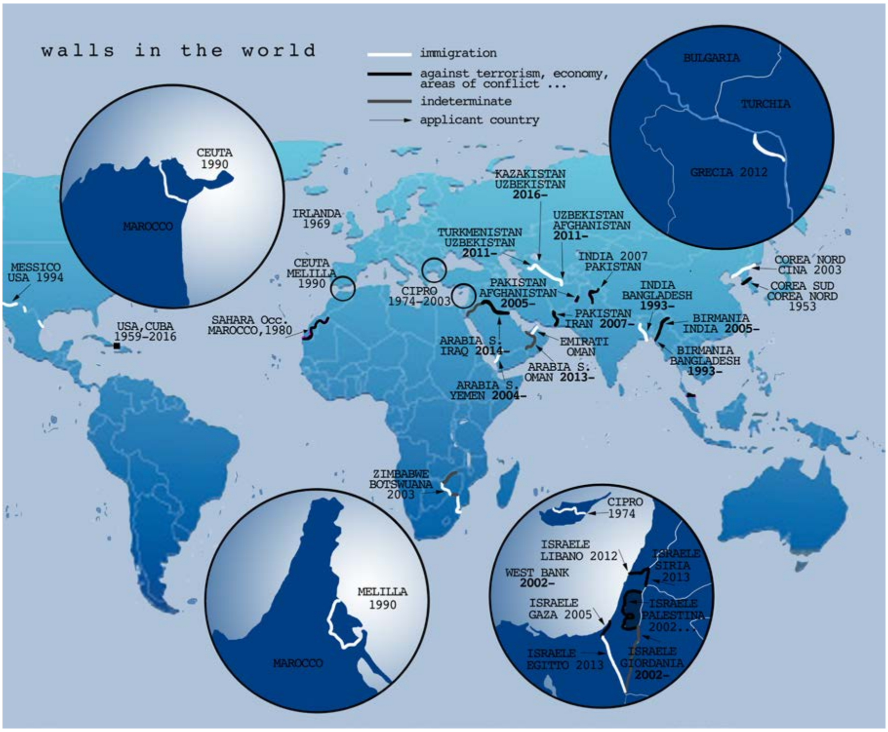

Fig. 1 Walls in the world

In particular, we can observe that in time, one of the most contested walls, often redesigned due to International pressure, is the Israel one, built in 2002 along the West Bank dividing a people and subtracting land illegally from the Palestinians. There are many other frontiers, starting from 1994 with 3.140 km of steel, cement, barbed wire always more fortified and military for the purpose of anti-immigration that separates the United States and Mexico, and the one that divides North and South Korea. We can also remember the barricade that divides Thailand from Malaysia, built to prevent Islamic terrorist from invading. There is also the electrified limit that runs along the frontier between Zimbawe e Botswana, in Africa. (Officially set up to block wild animals from passing from one place to the other, but actually to contain immigration in Botswana from refugees coming from Zimbawe). In addition, we have the 3.300 km wall built along the long frontier contested between India and Pakistan and not far from there the wall the 2.400 km wall which separates Pakistan from Afghanistan. There are also more than 4.000 kilometers of barbed wire which India is building to isolate Bangladesh while another barrier, of another nature is between Uzbekistan and Tagikistan, a limit equipped with sensors and video surveillance devices useful to prevent migrant

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passage. The same exists between Yemen and Saudi Arabia as well as the one between Oman and United Arabs Emirates where there is a cement frontier like between Kuwait and Iraq (215 km, reinforced after the Gulf war) and also Turkey and Cyprus, in this case a limit necessary to delimit the territories claimed by Ankara. In the Mediterranean basin there is the well know electrified Spanish barrier built to mark the borders between the Spanish enclave of Ceuta and Morocco, a territory which politically belongs to the first but geographically to the latter, actually, marking ideally the impassable line of division, between Africa and Europe. Therefore, the material borders that divide the world are many, set up for many different reasons but with the aim to divide, isolate, just like in Brazil where there are many 'walled communities' or even better where a wall does not become a prison but a protection. One can say that this political-geographical scenario is slowly delineating a bit everywhere. Therefore, walls that are more or less known, more or less long, more or less military style, passed or present, built for different reasons but all have in common one thing: the fear and inability of finding solutions. In his film, Il passo sospeso della cicogna, 1991 Theo Angelopoulos, had one of his characters say: "Do you know what a frontier is?... if I take another step I am something else; I am dead" (Fig. 2).

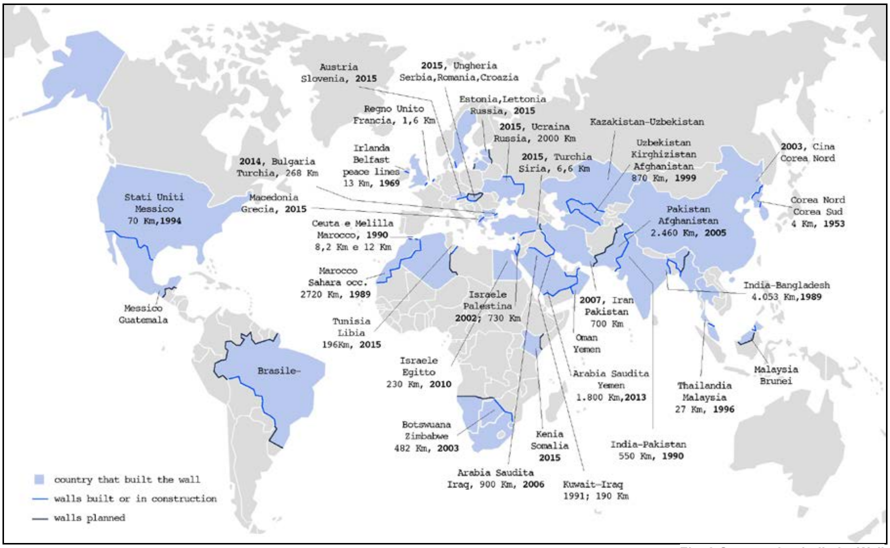

Fig. 2 Country that built the Wall

2 GIVING ROOM TO MISUNDERSTANDING

It is true that walls separate but they are never eternal. Walls are needed only to waste time and as the historian Frederick Taylor affirmed concerning the Berlin wall: "You can stop people, you can set limits but they will always find a way. Walls show politicians have ended their ideas concerning what to do in a difficult situation, not being able to find an alternative". It is about the lesser evil needed to demonstrate for example the past Serbian Bosniac conflict that we might call a 'trench' warfare, a conflict of search for space, that is, a conflict caused by chaos, by forced cohabitation, lack of land organization whose main objective was the conquest of space, limited space. We read in effect: "The frontier does not isolate, it filters. Frontiers no matter how arbitrary, they are essential to find again the necessary identity to exchange with the other […]there is no democracy without capacity on the part of the citizens to give each other

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limits" (Latouche, 2012). Therefore, in this game of land partitioning (more or less intricate and complex) why not go beyond, violating the wall and hypothesing a plan of space redefinition, a different form, far from the idea of barrier, of physical line? The idea is a flexible system, absolutely changeable and dynamic. Actually a space as a temporary filter, non continuous, fragmented in parts where the overlapping, antynomics take concrete form in order to conquer space the 'right measure', become recognizable, places taken out of any common definition and cognition but identifiable as spaces from changeable property. The border becomes an element that separates and to overpass it does not mean to negate its presence but rather its momentary transformation in open space, crossed space. In this anomalous condition the border takes on a varying importance, a different weight in time and space to the point of breaking up or even dissolving. In the end, the boundary becomes terra vague where time dilates and without contrast, 'misunderstanding' dwells, very little is needed for a conflict to break out or a misunderstanding and the chaos that reigns represents the main reason, the peculiar character from which to start, from which to put forward other realities. So the 'wild land' takes place where everyone thinks of himself and everything becomes possible between the cracks of the violated boarder transforming into 'no man's land' and as Claudio Magris said: "[…] camp out or settle in the promised land or at least in the desert in order to reach it […]". (Magris, 1986). It is then worthwhile that this complex reality, directed to the masses, to disorder, finds a solution, and can be compared to the desert, always, considered an element of separation between fertile realities, inhabited by nomadic populations which have continuously passed with their caravans and according to other prospective, they consider border land the one that is commonly controller and inhabited. Another perspective is suggested in such a way as to speculate in the analysis of the contemporary urban scenario, staying at the limits as arbitrary, a questionable environmental performance, more or less sudden, more or less violent, more or less coherent to the same social, political, cultural order that faces, in civil administrative relationships, a continuous adaptation only because being a foreigner, as Simel used to say: "means that the subject far away is close" (Simmel, 1989) that is, that every time a foreigner arrives at a state of disorientation not only civil but also in terms of space. The reason for this intrusion is a sharing of spaces that need some kind of organizational form and re-measuring. There is a need of a transition threshold since migration in any case always implies a certain civil and territorial turmoil, a place that for geographical or fundamental reasons becomes an opportunity for a meeting. We can then say that the space in the borders is practically a 'narrative beginning' that is a place animated by fantastic feelings, of hope and possibilities all to discover. An organized space, often with urban traits, a sort of city we can say 'a border city', as Despina was: a city between two deserts, a city as a Italo Calvino wrote in his work *The invisible cities*: "The city appears to be different to those that come by land and to those that come by sea […]Every city receives its form from the desert it opposes; and so the camel driver and the sailor see Despina, a city of borders between two deserts" (Calvino, 1977). Despina seemed to be a, 'mirage city', 'a deserted city' one that did not belong to one part or the other; a city that went against both, that remained free becoming an active membrane, a meeting place between people of the sea and of the land. Despina revealed itself as a changing urban system according to where the traveler was coming from and so a tangible proof of the territorial complexity: changeable according to the point of view, from where one was coming. Therefore, the sense of such a barrier, if real, becomes not only a widened space but also a tool to guaranteed confrontation, between people and culture. Just like Kevin Lynch suggested in The Possible City: "New cities that could be built for political reasons, just like the past…Urgan regions that could be founded deliberately between borders, where relationships are reasonably friendly, or as buffer zones internationalized between nations in conflict" (Lynch, 1968). In the present scenario a useful example could

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be the city of Panmunjom which actually declares itself as a point of contact between two worlds, one as ‘Lando of peace’ as the south Korean architect Kwaak Young-hoon design suggested proposing a great park with the purpose of designing Mount Sorak (South) and Mount Kumgang (Nord) in order to make them become symbols of the reunification of a Land notoriously in war and that even today reveals is inhabited by soldiers, suspended in a state of attack and one of defense. The project at the moment is only a utopia but the way is correct. It’s a question of time. In the end, only through a fusions of horizons (or at least according to the term used by Hans Gadamer) can mutual understanding occur: cognitive horizons able to breach the wall, going beyond the political-territorial divisions which have always existed, in fact, a world which is sort of more or less fortified bulwark, more or less impregnable so to suggest 'border worlds' that are 'city', 'reality in between' as Lynch said.

3 CRIMEN TERMINI AMOTI

Has the contemporary society deleted like in the Faust legend all its limits or has it simply moved them forward? Has the contemporary society marginalized, sometimes replicated, violently claimed and even strengthened its limits? In fact, in the current scenario, new, visible and invisible, walls, that establish stringent exclusion and inclusion criteria have been erected to separate individuals and peoples, although sciences and techniques seem, paradoxically, to cancel all both spatial and temporal limits. This could be interpreted as an implicit declaration of surrender, of 'impossible global ', of never realized promise, as if we said that world only virtually and potentially 'borders' but, in truth, it fragments and closes more and more. However, to what extent do we live a global reality with blurred or even non-existent boundaries? In front of such a discordance is necessary to re-think the idea of limits whose knowledge has been partially lost, but that, in any time and space, claims a specific recognition and identification. Moreover, since Aristotle, only what was done and provided with edges and contours was considered important and examined. Perfection was: to have a limit (peras). The infinite (apeiron) was a negative concept, synonymous of amorphous, confused, incomplete, vague. In order, to understand the limit, it was necessary to know both sides. Thanks to Giordano Bruno, philosopher par excellence of the “going beyond”, of the “violating all limits”, an idea of cosmos with no center and no periphery was formed, the problem of ‘on this side and of on the other side’ was circumvent and therefore the barriers of universe fell and consequently the plurality of worlds was accepted and a feeling of freedom and independence was conquered. Well, what it is today the prospect, what are the aims of the modern soul if the Baudelaire defined it: “Notre âme est un trois-mâts cherchant son Icarie”. In response it could be said that a world from which we start and never arrive arises. This is a boundless world, a global world that involves sometimes the destruction of all barriers and sometimes pushes the closure of fear (of which warned Bauman) or for defense. It is appropriate to ask, then, how, today, it is possible to find the right balance between: private dimension, which inevitably tends to form a 'Ptolemaic' order with the self in the center, and the public, more open able to cope with differences dimension. What will be the next geographical map, how many colors will highlight the national, continental borders? So what will be the 'measure' of the real world, such as physical boundaries, such as the walls that divide the world? You could say crimen termini amoti, although the boundaries of states and nations, in the name of treaties, international agreements, do increasingly blurred, provisional, they move with the subjects in the same horizon, closed to be opened, made to be violated. Perhaps this is just the first sense of progress, it is understood as a transgression, excess or abuse of power, in a word: hybrids, a going beyond, a continuous flow, a peaceful invasion, a proceed very different from the principle of good conduct suggested by Orazio: “There is a measure in the things, there are clear boundaries beyond which and before

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which it can no to be the right." Therefore what meaning and value have now the territorial and spatial limits? Why those lines are obstinately reformed? What thickness, what organization will have inhabited borders? In fact, there are many walls that still resist, each with their history, their contradictions, their reasons that 'justify' their existence. Just think that concrete lines extend in different parts of the world with a total length of 18000 km. The global list of walls is very long. This demonstrates that after the sad season of World Wars the barriers are not only stable, but even increased. Indeed much divisions has been made in last decades. From the map of Eric Mottet is calculate about: 11 Walls built between 1947 and 1991; 7 built between 1991 and 2001; 22 walls between 2001 and 2009; 11 walls between 2010 and 2015. Therefore, we can not consider the walls a matter over, gone. Borders and walls may be needed and necessary. Not only at institutional level but also cognitive. They determine who and what is In and who Out, all indicate: 'who is beyond the wall': the enemy, the monster, the criminal... and in the world they are needed as geography and maps, they are useful to guide us, tell the political changes, environmental and reflect the changes in the distribution and organization of power on the basis territorial. However, the current disorientation reveals the decline and, in some cases, the total negation of the landmarks, the identity values, history and social culture. So, the sudden and violent transformation of the idea of limens, as it was in the Roman Empire, has gone shattering in the Wall or rather in the construction of physical barriers, in barbed wire or in concrete un-matching. In fact while our 'World' has become increasingly large and increasingly closer, the Territory has ended up dividing and closing, as a Anthony Giddens' definition reminds us: "Globalization looms over us in a space-time stretching" or rather, it appears the end of the common space-time relationship because the overrunning is usual, everything that happens in a place, even far away, can have immediate repercussions 'here and now'. In this instant. Not only because everything is reproduced and amplified by the media, in real time, but also because the infrastructure have become faster and more direct. Therefore, the idea of limens falls, the boundaries have no identity value and they can no longer defend us, but we still feel the need of them: to organize our lives, to feel part of a culture, to feel secure, to get an idea of control and corporate governance. Therefore we need order, maps to guide us. Although the global world tends to deny it, the constant migration of people shows a multiplication of walls and borders. Recently, in particular after 1991, and especially in Europe and Eurasia, 27000 kilometers of new borders have been drawn while new walls rise everywhere. Only between 2009 and 2010 Michel Foucher had estimated 26 cases of cross-border conflicts, despite anthropologists as Francesco Remotti or representatives of inflexible international thinking discourage any distinction and deny any barrier, looking forward to a global world. A world crossed, inhabited by people in travel, habitués of non-places as airports, stations, ports. People want physical barriers in order to fence off identities and territories. In opposition to this dominant and hegemonic thought we could say that rather than globalization should say like Verdi: "Go back to the old and will be progress!". The project of all those places that, on limit, become transit spaces and even stopping, meeting, in the current landscape conquer a constitutive value since locus, as an opportunity for contact and also crossing. So, this is a promise of the formal, tactile, sensory quality testing, of the border lands that, as on limit, conquer thickness and social and environmental value. In border lands we experience more and more nomadic conditions, temporary and therefore ready to comparison actions, open to diversity, devised to be explored from the inside instead used from distance. We can foresee a 'mirage Earth', a 'Borderland', an 'online Earth' that as a road: at the same time unites and divides worlds more or less similar, worlds more or less in agreement, worlds that along the border tell different stories in which paradoxical situations take form. So, neither city nor country, like a river that divides territories, that continuously changes, beyond which 'multiply signs of ancient and daily floods', whose inhabitants are no

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citizens or refugees but only ‘border people’. They are condemned to movement or standing still, poised between memory and hope. Therefore places become like 'impossible towns', spontaneously inhabited, overflowing of a responsibility to remember identity left and not yet forgotten, full of provocations due to need of territorial and institutional control. As well as places are recognized: Earth ready to a strange marriage between what end and what born again in a continuous shuffling of time and space, of plans and controls. In other words, to inhabit Middle-earth means to float in an eternal passage, we never know where we are exactly; a kind of allegory perpetually open on the unexpected where, sometimes, everything seems prepared, adjusted but in conflict with non-measurable events of the customs. The impression is that the systemic and orderly plane imposed by Countries and United Nations seems to be inappropriate, discordant to emigrant’ life who lives 'the wait'. Perhaps the aspect that is most curious, in fact, is the rigid schedule of inhabited spaces that ultimately transforms a place, that is thought to be crossed, in an uninhabitable desert where rampant disorder and compulsive hack prevail. Therefore, it is necessary to find, among the large mesh of the general structure of the border areas, the way to 'escape', to reinterpret, to manifest the habits and traditions of those who lives there, to protect the people identity and to denounce the excess programming such as tragic limit of planned system. However, anything can happen in a hypothetical meeting on the border in which we envisage a game made by a potentially infinite number of rules. Therefore, places that have other places in them, confined spaces, blocks, composed of discontinuity points as they were: prisons, barracks... but still regulated by an orchestration of contacts and cross-contamination. In short, in the 'mirage Earth', in the ' impossible cities' everyone can have the form in an implicit surrounding declaration and of impossibility and the orders of a despotic architecture can offer to the Lands of arrivals and of departures a sacredness aura, a kind of modern sanctuary, a dimension suspended like a promise no maintained, an intention due to remain such. In other words, the places where mixed, became 'kaleidoscopic', constantly negotiated, changing and elusive where, tumultuously, add up and cancel out the most different contradictory feelings, the most controversial, indecipherable signs of multitudes that moves from point to point, no longer perceiving the space changes and the distances quickly crossed, perceived only as pause, a moment, a suspended vacuum, willing to give shape to continuous, inform and labyrinthine realities where there is no demarcation and there is no center, where we can open imaginary spaces, dream spaces that, in truth, become interrupted areas, border areas, opposing areas ordered to hold together an antinomic state of universe that struggles in the conflict between 'virtually global world and real barricaded world. As if we find ourselves at the boundaries of the planet, on the brink of an' underworld ', on the run from the system of limits against which, however, often we encounter and where the ‘tomorrow city’ takes shape. What is the promise in the dizzying game that, in the time, becomes more articulate and with the gradually growing web, that connects all the elements, gives shape to a reality in which we find ourselves not as the spider that created it but the imprisoned prey? Evidently the Borderlands, suspended in an aerial condition, nebula, where everything is intersected and exchanged, in a pilgrimage of people whose prospects are tricky and of difficult temporal and spatial ordering, they assume variable thickness, they become receptacle of contradictions, and even of ephemeral architecture, precarious and often unusual, without any value. How architectural design can establish a relationship with the marginal reality, contested by most identity forces and also by different temporal meanings it is still to be seen. At times, an architecture is revealed that shows authentic social identity, intended not as usual but as surprise, warning of common dynamics that to the limit get complex, reason for conflict. Therefore architecture depending on the connections, on expressive harmonies able to communicate the sense of necessity of logical forms indicating the real that becomes an inexhaustible source of knowledge that is a place of discovery and

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fascination in which, through the imagination that allows you to go beyond the appearance of things, it is possible to establish formal analogies between worlds and different cognitive processes. Imagination not of foreign worlds but of a world in which, about our lives, the meanings are revealed in order to delineate a boundary space that represents reality and its meanings, not as 'line' but project done according to a prediction logic, a projection of future planning. So, a world is advancing with rhizomatous evolution like explained by Beleuze and Guattari in *Mille piani*. An idea of multiplicity not as an adjective but as a noun (to be of multiplicity) in which the 'rhizome' structure becomes decentralized configurations where each part can be connected to another without go through significant points, as the infrastructure network or even the virtual system of global contacts. In other words 'rhizome' as reticular organization in a community in which we find culture and knowledge and that is the basis of nomadic thinking done by intersections and juxtapositions. In short: not line but project in which root and rhizome are not given only once but have to do in a perpetual procedural contingency. We could say a becoming that is a line and not just a point, a tension-space: 'between' and not 'from-to'. The important is the process. In the states of things we do not know about alternatives between forms but with mixed states in contact with each other and so it is starting from this idea of 'network' that takes forms a territoriality as de-localization respect to which it is possible to hypothesize a decoding dynamic, a sort of re-territorialization that is inhabited by relocation instances. So, de-localization can be understood as a principle of procedural openness but which, in absolute terms, is free from any partial re-territorialization to have, instead, a more general 'profile'. A complex world is coming in which the territorial closures with their claustrophobic and repressive aspect represents the common condition and the absolute relocation that is the responsible of scenarios that, although different, have to reveal their selves disturbing, and, today, in doubt, confused, indeterminate even if real. Moreover, every social group consists of fixed parts and other in moving that escape and sometimes 'clash' on the 'door' of other States, Nations that operate in 'binary encoding': In or Out so to slow down, stiffen the migrations in 'temporary structures' and so determining an uncertain and controversial territorial reconfiguration. The problem is certainly not to sustain the spatial closing neither the segmental, temporary relocation but rather a plane to favor orchestration processes between closed systems and spatial and cultural reconfiguration processes. It is supposed, as seen before, the approval of the 'misunderstanding', the 'gap' that activates new possibilities, that frees, connects different realities so to combine different environmental 'segments' and to amplify regional potential. Then we stay in opposition to the Hegelian dialectic that makes uniform the richness of the differences in the binary code of the oppositions, that stifles the event, that subordinates the affirmation to the negation, to support, instead, a design methodology able to sound the polyphony of the differences freeing from uniform of permutations of the Hegelian dialectic and, like the Foucault' (1985) analytics, to locate a macrophysics of power that acts as an instance of stabilizing and ordering of flows, relationships and multiple formations. Well, the spatial reality that, in different way and forms take shape along the boundary lines could be said multiple in which the project of ground becomes base of this occupation, of this apparent contradiction between nomadic and stable, and where there is a new map of the delocalized space that increasingly requires of a design thinking that sometimes becomes 'hard' and sometimes 'elastic', sometimes 'insurmountable' and sometimes 'flexible' ... in short, it aware of a global, unlimited world but also fragmented, interrupted and fenced world. Therefore, it is right now that a new perspective takes form, a modern vision that outlines the contours of the marginal spaces as chaotic reality of suffering and devastation in which there are, however, small oasis of tranquillity like it was the 'Lazzaretto' described by Manzoni: a kind of representation of the city in the city as a paradoxical form of 'positive heterotopia' or rather a hell that reveals glimpses of the future. We might say a 'bubble of

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civilization', where everything is so agitated as in a fantastic acceleration of time that allows the coexistence of opposites unthinkable elsewhere, a receptacle for multitudes ordered to a despotic system and mindful, however, of a cultural, environment value to respect and preserve. It goes delineating 'Beyond the Wall': a radical way of making underlying to the relationships that connect alternative ways, a provocative vision as a provocation to regulatory and standardizing thinking. Moreover, since Antonio Sant'Elia' unrealized visions of the New Town, Yona Friedman's Ville Spatiale, Constant Nieuwenhuys' New Babylon, to the avant-garde provocation of Archigram' Plug-In City, The Continuous Monument of Superstudio, and No-Stop-City of Archizoom and much else, a compositional, active and reactive thinking is confirmed that can give shape to a complex urban dimension, in constant metamorphosis, a city made up of multitudes of hybrid spaces in which divergent ways to do and to think architecture collide and transform. A discussion takes form that can reformulate, rethink alternative models of 'living', not only dictated by aesthetic trends or talent of a particular architect, but by the coordination or lack of coordination, by indifference and simple randomness of rules, of interests, of economies and of policies. The result is a way to compose that answers to more dimensions in a same time, organized to integrate various sectors instead to choose one or another and to tell the sharing, to integrate the pragmatic with the existential, the relevance with boldness, the creativity with common sense. The end of this reflection is Ludwig Feurbach' text taken from the Contribution to the Critique of Hegel's philosophy: "The God Terminus stands at the entrance of the world. Self-limitation: this is the condition of entry. Nothing is accomplished without realizing oneself as a determined being. The species in its fullest incarnation in a unique individuality will be an absolute miracle, an arbitrary suppression of all laws, of all principles of reality. It will be, in fact, the end of the world".

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AUTHOR'S PROFILE

Silvia Dalzero has an architect since 2006 and a PH.D. in architecture with a thesis about urban transformations in relation to disposal systems waste. She obtained a research, at the University of Architecture in Venice, IUAV, in theme of 'Ruins, debris and rubble in the theaters of war'. She also, in 2018 in IUAV, obtained a scholarship about of recovery of mining areas and, in University of Architecture of Pescara, a scholarship about of territories destroyed by war or natural disasters. She has a collaborator, since 2011, on the teaching at the IUAV in the course of Architectural-urban design (prof. Alberto Ferlenga). She was professor of Theory and practice of architecture (2012/2013), Architecture of the public space (2013/2014) at POLIMI and since 2014/2015 she has a professor of Architectural-urban design (in the first year), at University of Architecture in Milan, POLIMI. In 2016/17 She also was professor at Academy of Art in the course of Design (in biennium of specialty). She has several publications including the monograph 'Rejected landscapes-Recycled landscapes. Waste disposal and recycling sites, perspectives and contemporary approaches' published in January 2015 by Scholars-press.

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THE TERRITORIAL FRAMES

A NEW INTEGRATION MODEL FOR LOCAL DEVELOPMENT

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ABSTRACT

The topic of local development, and in particular of its spatial components, nowadays seems to have become secondary in the planner's agenda. The phenomenon of metropolisation has in fact assumed dimensions not foreseen by planning, which, despite the continuity and homogeneity of the processes, has almost completely outclassed that of territorialization. With respect to this, traditional planning has not elaborated instruments capable of interpreting and governing the processes of meta-formation of the territory and of landscapes. An attempt was made by a research of the University of L'Aquila which used an original model of interpretation and governance of the spatial development processes called "Territorial Frames" (TFs), that deals with some issues related to the development of the European space and its territories, with particular reference to equity development, balance of resources, efficiency of settlement and mobility systems and integration of strategies and projects between different regions. These are issues that do not seem to be resolved only by the polycentric model referred to the European policies.

The research presented is developed in three phases: (1) the definition of TFs at different scales, European, national and local; (2) the integration of the TFs model with the macroregional one at european and national scales; (3) the application at regional/local scale of the integrated TFs for new cross-scale development processes. This article presents the first results of this phases, with a local case and particular reference to the TFs of the inner areas of central Italy.

KEYWORDS

Spatial Planning; Spatial Policy; Macroregions; Governance; Cohesion; Glocalization

1 INTRODUCTION

The topic of spatial development of the European context and its territories, is at the center of a University of L'Aquila research entitled "Project of the post-urban forms, the sphere of the plan". This research introduces an original interpretative model of the European space named "Territorial Frames – TFs" (Di Ludovico & D’Ovidio, 2017), oriented towards the equity of development, the balance of resources, the efficiency of settlement and infrastructural systems, as well as the integration of strategies and projects between different regions (coordination/co-planning) (Hall, 2016), but mainly oriented to provide a basis for reintroduce the spatial planning today in crisis (Faludi, 2010). The research also concerns the criticalities not sufficiently addressed by the Polycentric model (ESPON, 2005), the guiding principle of the EU territorial policies, too focused on cities and networks neglecting the interlocked territories and in particular the weakest and most critical areas (local contexts/crisis areas) in which resources are struggling to reach (Act, 2013). The aim is to overcome the pan-European vision derived from the different models proposed by the literature on European trends in the last decades based on the ESDP, such as the Blue Banana and the Bunch of grapes, very suggestive from the point of view of interpretation but actually not very effective in terms of the cross-scale integration of policies and territories, and in particular for the development of spatial policies.

The TFS model addresses these issues, composing an interpretation of the European space, but also national and local, consisting of a territorial mesh on which to base policies for a new process of spatial planning based on the macroregional development (Macroregion is considered the governance reference of TFs-based strategic projects). The Italian Ministry of Infrastructure and Transport and the Abruzzo Region (IT) have already addressed these issues within a study named “Territory Project ‘Joint 2’ Abruzzo” (RegAbr, 2015) in which this new model of spatial interpretation (TFs) was proposed at the national level, large infrastructural quadrangles identified in the context of Median Macroregion – Central Italy (Di Ludovico & Properzi, 2012; Di Ludovico & Properzi 2015; Di Ludovico et al., 2014), characterized by differentiated settlement fabrics, amorphous products of the post-industrial era and variously composed (residential, industrial, commercial, agricultural, etc.). TFs can be considered a connective mesh with an autonomous and often diversified dimension and structure, which can recompose these fabrics.

The research is based on the sequential articulation of three working steps:

- the definition of TFs at different scales, European, national and local;
- the integration of the TFs model with the macroregional one at European and national scales;
- the application at regional/local scale of the integrated TFs for new cross-scale development processes.

This is a declinable approach both to the scale of European Macroregion and of National Macroregion, in which TFs assume a spatial role with variable geometry and proportionate according to the reference scale, with an increasingly thick and minute mesh to intercept the “local” territories and to fully exploit the opportunities derived from the “global” territories.

The research is now in the phase of deepening TFs, verification of their configuration and performance in terms of transport data and in relation to the theme of Digital Frames (DFs), as well as a first verification of the proposed spatial planning model. The aim of the research is to resume the theme of spatial planning, through a new cross-scale interpretative model oriented towards territorial integration, to Glocalization (Bauman, 1998) and to the valorisation/development of inner areas in a global context.

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2 THE MODEL OF TERRITORIAL FRAMES: FROM THE TERRITORY TO THE LOCAL

Spatial planning finds its direction in the assumptions dictated by the EU, substantiated on the one hand by the polycentric model and on the other by the different models proposed by the literature on European trends, as the aforementioned examples of the "Blue Banana", "Bunch of Grapes", "European Pentagon", "Red Octopus", etc. Although they are very seductive interpretation models, in the territorial planning practice they have not significantly contributed to the polycentrism development and to the promotion of European spatial planning, but rather they favoured the development of the debate on the European Spatial Development model. On the basis of these experiences, the University of L'Aquila research proposes a new interpretative model of the European area which first of all pursues the aim of a new European and national space planning season. This model, which we define "Territorial Frames" – TFs, is based on some methodological principles:

- the European polycentrism recognition and its evolution towards integrated networks of cities of a horizontal type (Camagni, 2017);
- the "spatial mesh" definition, determinate from TFs configuration, as a reference for territorial/spatial components (settlement, productive areas, agricultural areas, natural areas, landscapes, etc.);
- the cross-scale model definition, applicable both at European/global level and at local level (Kidd & Shaw, 2013), pursuing the strategy of variable geometry of "space meshes";
- the "spatial mesh" integration with a cohesive governance system, such as that of the Macroregion (EU, 2009), which is also applicable to the different reference scales.

2.1 THE TERRITORIAL FRAMES – TFS AND THE MACROREGIONS

TFs are infrastructural quadrangles whose sides are made up of the main European multimodal transport corridors, characterized by their completeness/incompleteness and on which flows of the freight and people are moved, but also flows of Digital information. Along these branches and their vertex are generally the main urban and productive agglomerations, the most important European cities, the main digital hubs (D'Ovidio et al., 2016). In our model, TFs, with their autonomous and often diversified size and structure, constitute the main recomposing "spatial mesh" of settlement systems and their post-urban/post-industrial forms (Choay, 1992), which spatial planning failed to govern by returning often amorphous settlements. Quadrangles are therefore space tiles (TFs) that contain large and small urban areas, more or less important productive areas, natural reservoirs or large agricultural production areas. Its branches (corridors) may also be affected by settlement (residential or productive) developments, either linear or polarized.

Fig. 1 on the left shows the configuration, first approximation, of European TFS (ETFs), to the right of Italian TFS (NTFs). In the latter, the branches of TFs are represented with a different thickness depending on the belonging to the ETFs (more often) or NTFs (less often). The research has differentiated these branches also according to their "completeness" (complete or incomplete infrastructural corridors) and the flows of the freight transport.

In the research, have been analyzed the frames that determine TFs in relation to their main components (settlements, productive areas, agricultural areas, natural areas, GDP, population, accessibility, etc.) and classified with two synthetic indicators, one of the physical components and the other of socio-economic components. These analyses were then used to define strategic projects for territorial development, which are now only experienced at local level (§3) contextualized in a new area of governance, where such strategic projects are shared by several regions, that is the Macroregion of the European type. This is an

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aggregation of regions that comes bottom-up and where common challenges are pursued. The meaning of the macroregional strategies is to seize those aggregates of economic-productive and social nature, that can be together, without necessarily having to create a new institutional entity that is added to the existing one (EU, 2009). The new European Macroregion with their innovative features are considered examples of territorial governance in which it is possible to experience spatial planning actions based on the development of TFs, which address the dualisms space/territory and territory/policies.

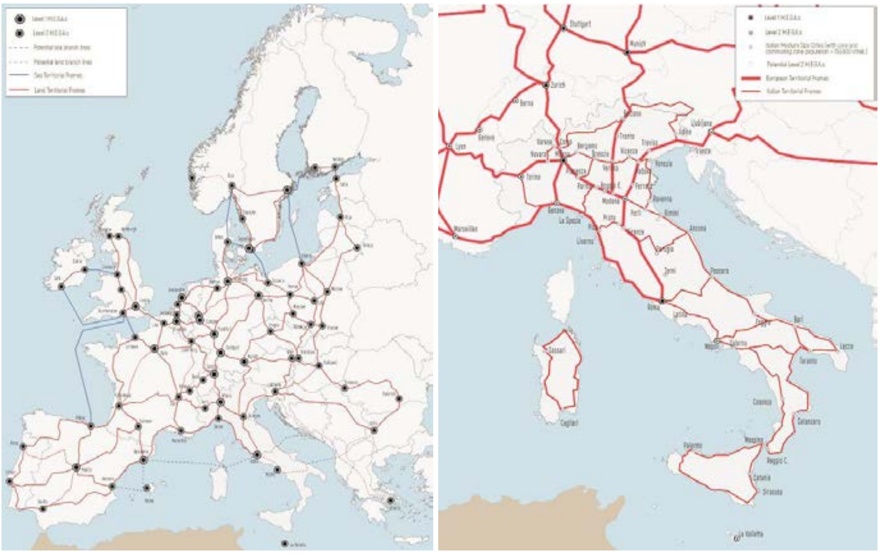

Fig. 1 The configuration of the European TFs (ETFs) (left) andthe configuration of the Italian TFs (NTFs) (right) (Source: Benedetta Di Giacobbe)

Fig. 2 represents an overlap between the ETFs with the perimeters of two (Adriatic-Ionian and Alpine) of the four European Macroregion now activated (in addition to the previous ones, the Baltic Sea and the Danube). In both cases it occurs that the ETFs are generally incomplete, critical issue that determines a structural weakness, in connective terms, of the Macroregion. In general, even according to the synthetic indicators, we are faced with a very strong Alpine Macroregion from the socio-economic point of view and a Adriatrico-ionic Macroregion (which partially coincides with the first) weak in which there is also absence of ETFs on the Adriatic area. The other two Macroregion, Danube and Baltic Sea, have instead a strong environmental and agricultural propensity, potential that can be developed also through the strengthening/completion of TFs and their components and therefore of the connective mesh linking these Macroregions to the local territories of the whole of Europe. These preliminary reflections, essentially show that we are faced with a macroregionalism without a spatial reference framework that can instead be implemented, albeit from the bottom, using TFs as a spatial mesh, the base of the spatial policies. TFs is therefore the reference that can help implement sustainable macroregional and local development projects (cross-scalar), tailored to the territorial capabilities described by performance-oriented indicators.

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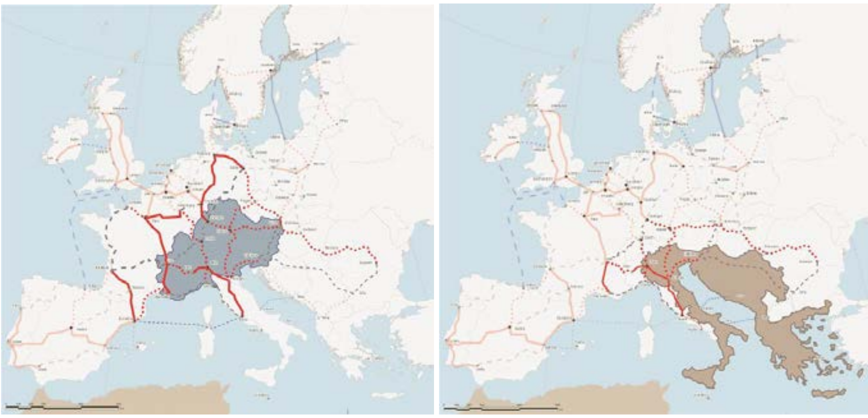

Fig. 2 ETFs and the Alpine Macroregion (left) and the Adriatic-Ionian Macroregion (right) (Source: Benedetta Di Giacobbe)

3 LOCAL TFS. THE INNER AREAS OF MEDIAN ITALY

The TFS + Macroregion model, both nationally and locally, was subjected to a first experimental test in the "Territory Project 'Joint 2' Abruzzo" (RegAbr, 2015) study already referred. In particular, the study, oriented towards the construction of a localized partnership in the so-called "Median Italy" (central Italy), had the objective of building common development projects with particular attention to the most in crisis inner areas (Act, 2013). In this case, it has been positively tested the opportunity to build a Macroregion (ant its partnership), the Median Macroregion (Fig. 3 on the left) (Di Ludovico & Properzi, 2015), and the opportunity to prepare territorial/spatial development projects based on TFs at national level – NTFs and local (Di Ludovico & Properzi, 2015; Di Ludovico et al., 2015).

Even these frames of national and local level, as for the European ones, were characterized through the synthetic indicators of the physical and socio-economic components, clearly showing the division between northern Italy, with strong industrial connotation, and southern Italy, with a naturalistic-environmental and agricultural connotation. These indicators were used as a design tool to define strategies to increase the performance of TFs and their components.

The identification of NTFs within the Median Macroregion has highlighted frames often incomplete, in particular in the south, derived from infrastructural deficits that isolated and marginalized the more decentralized and weak territories that were consequently left out from the development processes that have been concentrated around the big cities, from the metropolitan ones to the global ones (Taylor, 2004) and in the more accessible and competitive territories. In the vertices of NTFs there are often historical settlements and middle-level cities (Properzi, 2016) or metropolitan, which are then the urban poles in which the services of higher and rare level are concentrated. The connective branches of NTFs were sometimes affected by a post-industrial development for linear diffusion, with an essentially productive characterization (industrial areas) and commercial. Within the quadrangles of NTFs there are often agricultural activities, scattered settlements, historical villages, and also naturalistic areas and landscapes of great value.

In Fig. 4, on the right is a project process based on the development of local NTFs "Pescara-Teramo-L'Aquila-Avezzano-Sulmona" and its components as described above. It is a quadrangle that embraces an

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area that goes from the Adriatic coast to the Gran Sasso mountain, affecting one of the weakest and in crisis inner areas of the Median Macroregion.

The strategic project connected to this local NTFs, including those of the strategic framework of the aforesaid Macroregion, is spread over 3 axes:

- the Territorial Frames: completeness, strengthening, connection (with Europe and the internal of TFS);
- settlement development, local identity, research and innovation (with a focus on the earthquake area 2009 and 2016);
- enhancement of natural, cultural, landscape and tourism resources.

These three project axes are first of all based on the development and completion of the NTFs that characterize them. Then, on the implementation of the city networks, of which some poles are at the vertices of NTFs, but most are within the frame. These networks, whose components are tangible and intangible, connect the internal territories of TFS with the same TFS and therefore the “local” territories with the “global” ones and thus compete with all the regions involved (Di Ludovico et al., 2014), thus exceeding the unbalanced European polycentrism in favour of a “Horizontal (non-hierarchical) networks” model (Boix, 2003). We refer, in the first instance to the concept of integrated network elaborated by Roberto Camagni (Camagni, 2017), in which different logics overlap on the territory, both because of a temporal succession and because they refer to different aspects or to different types of activities, giving rise to a complex scheme of superimposed spatial structures. These are the “complementary networks”, formed of specialised and complementary centres, the “Synergy Networks”, formed by cooperating centres, and “innovation networks”, consisting of centres cooperating on specific projects in order to reach a sufficient critical Mass (Camagni, 2017). The research identified these networks only at the preliminary level, leaving their in-depth study to future developments.

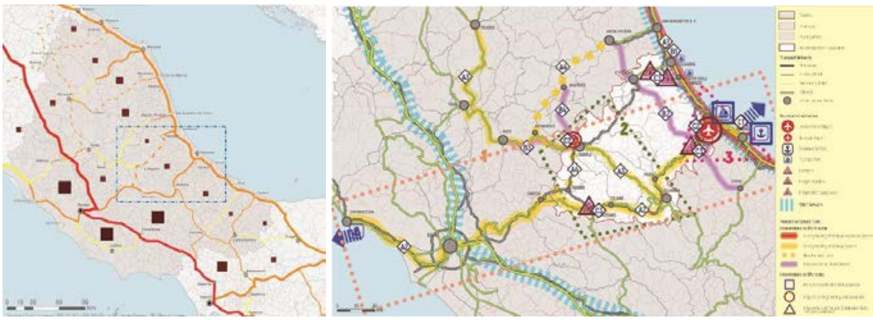

Fig. 3 On the left the TFs of the Median Macroregion (left) and the Strategic Project of the TFs "Pescara-Teramo-L'Aquila-Avezzan-Sulmona" / Axis 1 (right) (Source: Benedetta Di Giacobbe)

4 CONCLUSION

The research set out in this article represents the evolution of the Italian Ministry of Infrastructure and Transport – MIT and of the Abruzzo Region (It) study named “Territory Project ‘Joint 2’ Abruzzo” (RegAbr, 2015), which concerns the construction of a partnership located in the so-called Median Italy (Central Italy) oriented to the construction of joint development projects with particular attention to the most in-crisis inner areas (Act, 2013). This study investigated the potential of national macroregion (on the model of European ones), identifying the Median Macroregion as a reference for spatial/territorial development projects and laid

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the foundations for the design of the model of TFs applied in the research in a cross-scalar logic, from Europe to the local level.

The research has highlighted some limits and issues, which required to be in some depth. The absence of any European reference framework for spatial policies; the lack of data verified at national and European level (transport, landscape, cultural heritage, etc.); the vagueness of the polycentric model and its inability to adapt to the different scales; the lack of experience on new levels of governance.

The main objective of the research is to cultivate a new season of spatial planning geared towards the integration of territories through a cross-scalar approach, and to the activation of new sustainable development processes, with particular reference to economically disadvantaged inner areas in a context of macroregional governance.

The next research steps intervene on some of the criticalities described and apply first of all the deepening of the transport themes connected to TFs, then the deepening of the "Horizontal (non-hierarchical) networks" in relation to the mesh of TFs and internal territories to the same, and the role of so-called Digital Frames – DFs, a theme still unexplored.

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AUTHOR'S PROFILE

Donato Di Ludovico is a Ph.D., researcher of Urban and territorial planning and design, Urban design professor at the University of L'Aquila (Engineering). He carries out research activities within the new forms of Spatial and Strategic planning, Urban planning and design (safety and security), knowledge and assessment systems (SEA). With regard to the Spatial planning, his research is focused on new models and new policies. He is currently secretary of INU Abruzzo-Molise section (National Institute of Urban Planning); director of Urban Laboratory for the Reconstruction of L'Aquila (LAURAq-INU/ANCSA); scientific responsible of AnTeA Laboratory (Territorial and Environmental Analysis) at the University of Aquila.

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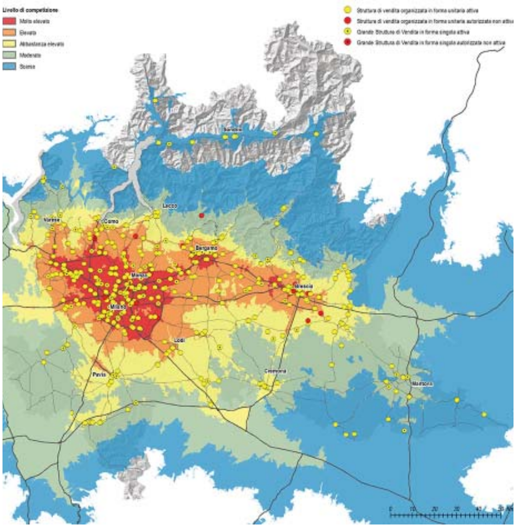

SUPPORTING RETAIL PLANNING WITH TERRITORIAL MODELS

APPROACHES, INNOVATIONS AND OPPORTUNITIES

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ABSTRACT

Over the last twenty years, Italy experimented a deep transformation of its socio-economic and technologic conditions, which influenced, among others, shopping habits and customers' consumption practices. These changes, which follows an incremental business deregulation process, had a strong spatial impact related with the competitions of brands, formats, offer systems, etc.. The evolution of national market and policy community needs innovative tools to support sectoral planning. The aim of this paper is discussing different territorial models that authors implemented within the recent activities of URB&COM Lab (PoliMI), analyzing Lombardy region and especially the network of "retail polarities" that currently shows specific development trends as new openings, refurbishments, re-location, crises and dismantling, demalling, etc. which have effects on the whole system, integrating – and often competing with – the offer of urban retail systems. We present two different approaches to the modeling using as a support to the public strategies, that take in consideration "static" and "dynamic" data. The integration of these two approaches produces usable descriptions of current regional market competition and of the attractiveness – and the performance – of the retail polarities. Therefore, we explored the potential combination of those models with specific focuses based on Google Places service, that allow reflections about consumption practices and their working profiles. The result is an updated, interactive and original knowledge, that supports sectoral and territorial planning, providing a new, integrated point of view about retail poles and their impact on regional scale.

KEYWORDS

Urban Retail Systems; Retail Poles; Demalling; Spatial Descriptions as Usable Knowledge

1 INTRODUCTION[1]

Over the last twenty years, Italy, as many others European countries, experimented a deep transformation of its socio-economic and technologic conditions, which influenced, among others, shopping habits and customers' consumption practices (Pellegrini & Zanderighi, 2013). These changes, which follows an incremental business deregulation process (D.Lgs. 59/2010, L. 248/2006, D.Lgs. 114/98), had a strong spatial impact related with the competitions of brands, formats, offer systems, etc. The evolution of national market and policy community needs innovative tools and approaches to support sectoral planning. The aim of this paper is discussing different territorial models that authors implemented within the recent activities of URB&COM Lab of the Politecnico di Milano, analyzing the Lombardy region and especially the network of "retail polarities" (Morandi & Paris, 2015) (Shopping mall, Big Boxes, etc.) that currently shows specific development trends as new openings, refurbishments, re-location, crises and dismantling, demalling, etc. (Cavoto, 2014; Cavoto & Limonta, 2015) which have effects on the whole system, integrating – and often competing with – the offer of urban retail systems (high streets, food hall, aggregates of traditional shops).

But in a context in which conditions changed radically, we overhauled disciplinary tools and sectoral approaches, to increase our knowledge about retail phenomena and their influences and opportunity in territorial governance (2). Therefore, in this paper we present two different approaches to the modeling using as a support to the public strategies, that take in consideration "static" and "dynamic" data, elaborating information about retail poles starting from open data sources and enriched with other specific sources. Resulting maps show the spatial distribution of current retail system in the Region, and an analysis of their attractive power, that takes in account features of poles and their contexts.

The integration of these two approaches produces useful and effective descriptions of current regional market competition and defines several factors that influence the attractiveness – and the performance – of the retail polarities. Therefore, we explored the potential combination of those models with specific focuses based on Google Places service, that allow reflections about consumption practices and their working profiles (3). The result is an updated, interactive and original knowledge about Lombardy region, that supports sectoral and territorial planning, providing a new, integrated point of view about retail poles and their impact on regional scale (4).

2 LEARNING FROM LOMBARDY REGION: A MULTICHANNEL, INTEGRATED AND COMPETITIVE MARKET FOR RETAIL COMPANIES

Since 1998 and the reforms related with retail sector (D.Lgs. 114/98) and the local declination of European and Italian regulation about competition (EU Directive on services in the internal market 2006/123/EC, commonly referred as the Bolkestein Directive and its national adaptations D.Lgs. 59/2010), Lombardy Region represents the most relevant market for retail companies in terms of number of local units and business, heterogeneity of brands, offers and innovation in concepts and formats.

[1] Although this paper should be considered a result of the common work of the two authors, M. Paris took primary responsibility for the section "2. Learning from Lombardy Region: a multichannel, integrated and competitive market for retail companies" and G. Limonta for the section "3. Supporting territorial governance through not-conventional readings of spatial distribution of retail poles" meanwhile the Introduction and Conclusions are a product of the shared reflections between the two authors.

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Moreover, the spatial distribution of retail services is not homogeneous and one of its key features is the interaction of planned retail poles (Brunetta & Morandi, 2009; Paris, 2014) – as large specialty stores (RICS, 2018), shopping malls, retail parks, etc. -, that have been developed between late 90s and the 2010 and existing urban systems. Due to the crisis of 2008, the development of this network slowed down but, in recent times and following European trends, it evolved in a new phase, marked by several trends that we will point out in the next section (2.1), that produced a need of new tools and approaches to support public actions (2.2).

2.1 THE EVOLUTION OF REGIONAL RETAIL MARKET

The evolution of Lombardy retail market shows a complexity that involve distinct aspects, that affect the consolidate status of existing retail systems, their transformation and the development of new trends (Limonta & Paris, 2017a). These are due to a set of different strategies implemented by operators – and sometime suggested by public policies – to face off structural and contingent crisis (2008-2016) after an expansive phase (1998-2008). Moreover, the final image stands for an articulated multichannel system, where emerge different kind of offers. Major two - planned retail poles and urban retail systems - show specific peculiarities, that increase the overall complexity of the regional scenario. The result of the interaction between different typologies produces an over-dimensioned offer of retail functions, that is changing due to selective processes of adaptation to new market conditions, where the competition between formats and companies produce innovation in offers, hybrid spaces that integrated retail with other functions and an increasing decommissioning of consolidate stock due to a process of progressive adaptation of market to current conditions and consumption behaviors (Tamini & Zanderighi, 2017; Tamini, 2018).

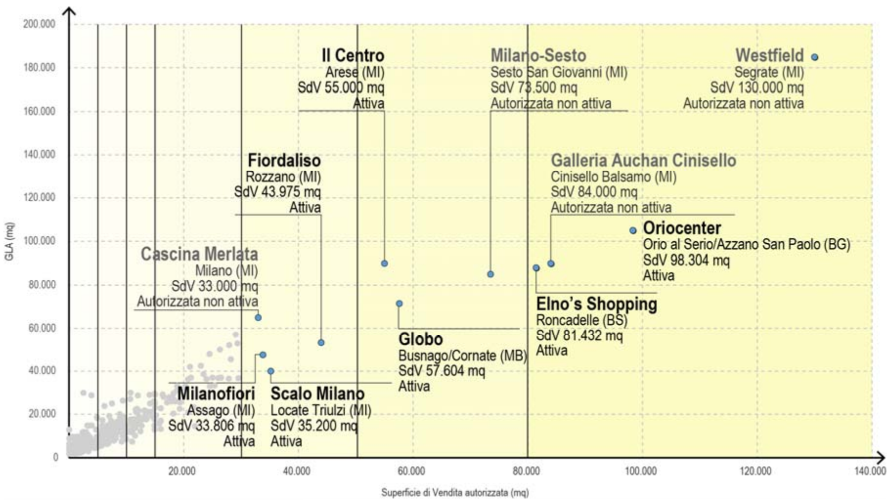

Fig. 1 The stock of 327 existing shopping malls in Lombardy Region (URB&COM Lab., 2018)

Retail poles

Four main trends marked the evolution of planned retail poles:

- the opening and the development of new venues that aim to achieve a role of centrality in regional space, due to their larger and larger dimension and functional complexity, where the consumption of

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goods, services and experiences produces a strong attractiveness of these "poles" that serve catchment areas that exceed their close contexts (Morandi & Paris, 2015) and achieve provincial and regional dimensions;

- the refurbishment of existing shopping malls, that aims to reinforce their role in an increasingly competitive market;
- the integration of retail with other specialized functions related with entertainment and leisure, culture, sport and horeca activities;
- together with these actions, that show the inertia of suburban poles and the re-action to the crisis of consumption developed by operators of large retail companies, it appears a variety of deadmalls and gosthboxes and some attempts to regenerate them with demalling operations (Cavoto, 2014; Cavoto & Limonta, 2015).

Urban retail systems

In Lombardy, together with planned retail poles there a variety of spontaneous or "natural" retail systems located in urban contexts resists. They integrated the regional network of retail offers and shows certain inertia and vitality, representing alternative to suburban shopping malls. Urban retail aggregates are characterized by the agglomeration of commercial and retail activities (not only corner shop but also arcades, urban shopping malls, supermarket and superette) that configure high streets or vibrant squares, where retail functions match and coexist with other commercial activities (craftsman, restaurant and café, creative and cultural industries, culture and entertainment, advanced services, etc.). In other cases, retail and commercial activities does not create those agglomerations and their fragmentary spatial distribution don't produce any synergy or added value in terms of attractiveness.

In recent publication[2], we focused on municipal retail trends to describe the fragility of retail systems through a complex indicator (Limonta & Paris, 2017b)[3].

These focuses depict a rich variety of situations, with some municipalities under pressure due to the attractiveness of planned retail poles and other local retail systems. These maintain a vital economic presence and a potential local retail system that are not weakened by competition (as in major cities - as Milano, Bergamo, Brescia and Monza - and the municipalities along the Milan-Turin motorway), and in some instances they are improved by the compactness (as in Milan and some peripheral municipalities). Together with these trends we should take in account other kind of factors that influence consumption practices of Lombardy Region, as the increasing role of ecommerce, or a progressive shift from a consumption economy to a sharing one, etc. that integrate - and sometime, compete – with traditional offers.

[2] The article presents the outcome of their research agreement within Urb&Com Lab – DAStU, Politecnico di Milano and Polis-Lombardia, entitled "Analisi delle criticità e delle opportunità di sviluppo del fenomeno della dismissione commerciale ai fini dell'attrattività urbana" coordinated by Prof Luca Tamini, within the research project "Attuazione strategie europee 2014/2020: individuazione priorità e linee di azione ed evento di confronto sulle tematiche del commercio tra le Regioni dei Quattro motori" financed by Èupolis Lombardia (Decree no. 2771 of 1 October 2014).

[3] Data was obtained from a regional observatory, in order to track the evolution of municipalities in the period 2008-2011 and understand the dynamics of local networks of stores (increasing, balance, decreasing). The was then cross referenced with ISTAT data from the Industry and Services Census 2001 and the Industry, Services, and Non-profit Institutions Census 2011, regarding all retail activities (horeca, services, handicrafts, etc.) that were usually part of the shopping experiences of users.

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Fig. 2 Le Acciaierie in Cortenuova (BG) – exterior of an abandoned shopping mall, opened in 2005 closed in 2014 (URB&COM Lab., 2018)

Despite the relevance of these issues, in this contribution we will focus more in these aspects related with the physical retail network, leaving these digital or immaterial topics – and their material supports - as background. Therefore, in the next session we will point our reasons and opportunities for a change in the approach to retail system in policy community.

2.2 A NEED OF NEW TOOLS AND APPROACHES FOR POLICY COMMUNITY

Described typologies form a multichannel retail system, in which customers choose from time to time, how to develop their consumption habits, considering a variety of criteria (as easy access and proximity, low prices, products' quality and merchandising mix, opening time, but also quality of contexts and urban environment, richness of consumption experiences and functional mix, etc.).

Customers point out strengths and weaknesses for every typology of this multichannel retail system. Actually, they never focus just in a single possibility, but they differentiate their experiences and their consumption habits due to the opportunities that planned suburban poles and urban retail systems provide.

This process produced a set of deep influences in retail companies, that affect their market strategies, their settlement behaviors and their branding and marketing policies. The result has been a progressive transformation of retail offer, in which we pointed out an incremental market saturation and an adaptive evolution of existing network, where co-exist different dynamics[4]. Together with these dynamics, those structures less innovative and attractive suffered a process of accelerated obsolescence and dismantling especially where the offer is sprawled and not attractive for users/customers.

The co-action of these factors affects not only on retail field, but influences flows and infrastructural patterns, employment and social practices, local and regional economies, territorial attractiveness and urban vibrancy, safety and the quality of built environment, etc. The result is a complex dimension, which cannot be explained only through sectorial logics and which must be considered in public policies, as a field which influences territorial growth and its sustainable development, and where a governance is needed. Therefore, it emerges a demand for new spatial descriptions, that exceed the conventional and over-simplified current narratives (Manfredini & Villa, 2012) of retail phenomena. This original, specific and orientated spatial

[4] As new gigantism of external and multifunctional poles, urban re-centrages (Bagnasco, 2003) based on the role of competitive formats (food superette, mix offers of food selling and consumption, specialized medium-sized stores) and a multiplication of new openings (big boxes, hard discounts, entertainment centers) on peripheral contexts, sometime concentrated along important infrastructures or their crossroads.

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knowledge (Dovarch, 2016) could be used to comprehend current territorial realities and to define specific strategies and actions. Moreover, these new readings, based on data and interpretative keys, must be open, transcalar and interactive, able to generate dynamic representations (Lombardini, 2016; Voghera et al., 2016) of these spatial phenomena. They should allow a systemic view of the retail dynamics and framing them in their territorial and not isolated dimension.

3 SUPPORTING TERRITORIAL GOVERNANCE THROUGH NOT-CONVENTIONAL READINGS OF SPATIAL DISTRIBUTION OF RETAIL POLES

In a recent research[5], we explored an approach oriented to the description of Lombardy Region retail poles system, in which produced cartographies and elaborated data have supported the definition of new regulative tools for traffic assessment and infrastructure management. The aim was providing to decision-makers and private operators an assessment tool for the attractiveness of retail poles able to estimate the number of visitors (and from this, the number of cars and generated trips) for each structure. Our aim was the definition of a protocol able to define flows distributed during the week and their succession during the day. Our proposal uses different kind of materials, mixing "static" data (location, dimension, offered products, etc.) with "dynamic" information in which we take in account relative positions of poles, their interactions and the attractiveness of their formats (especially when they integrate more functions or propose specialized offers). Testing this approach, we integrated the reflection with an exploration on Google Places data, that could support with an on-time update these focuses.

We involved outputs of these analysis to describe current market dynamic, competitive advantages or opportunities of locations and saturated spaces in regional context. This description allowed us to:

- identifying municipalities affected by a new opening (or refurbishment) taking in account its format, its dimension and the integrated functions offered within the retail pole. Therefore, we quantified the potential basin of a specific venue in terms of attracted inhabitants and, consequently, the number of families and vehicles potentially attracted by the structure (3.2);
- quantifying the pole attractiveness through the involvement of original models[6] that take in account the presence of competitors within the specific basin of each structure and the resulting competitive market (3.3);
- focusing on directions and rates of visitors' flows, distributing them on infrastructure networks that serve any pole according to its ranking (motorway, state/provincial route or local one), its features (speed expected, existing traffic, etc.) and performance potentials (3.4).

[5] Developed within the Research Agreement between Polis-Lombardia (I) and DAStU – PoliMI, titled "Valutazione del traffico generato/attratto da trasformazioni urbanistiche-insediative e da grandi strutture di vendita", coordinated by P. Beria and where authors took part as members of research team (headed by L. Tamini) in 2017-2018. Urb&Com Lab has been called to (a.) Defining the spatial distribution of retail poles (Shopping mall, big-boxes, FOC, etc.) in Lombardy, (b.) Interpretating the regional context, (c.) Focusing on rhythms and cycle of attractiveness through Google Places data, (iv.) Supporting the definition of the new regulative approach.

[6] Gravitation model that the Lombardy regional authority implemented a gravitation model for the assessment of impacts on labour market of new openings of retail poles (DGR X/1193, cfr. 3.2.2). The base for those quantifications is our re-interpretation of this model, in which we applied the same variable of distance (misured in travel time) to identify the real attractive potential of each structure for visitors.

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3.1 STATIC DATA: DESCRIBING THE SPATIAL DISTRIBUTION OF RETAIL SYSTEMS

In the first focus, we represented the spatial distribution of poles according to the data provided by the Opendata services of Lombardy Region[7] considering their dimensions and their typologies. Therefore, we provided a specific focus for those poles "organized in unitary form" (*Grandi Strutture di Vendita organizzate in forma unitaria*) and the large specialty stores (*Grandi Strutture di Vendita organizzate in forma singola*) as defined in section 2 "*Definizioni e altre disposizioni comuni*" of D.G.R. X/1193 del 20 dicembre 2013, the regional law that provide a specific taxonomy for these structures.

<u>Poles organized in unitary form</u>

This channel comprehends: Shopping malls (with its declinations "Aggregated shopping mall" and "Multi-functional shopping mall"), Factory Outlet Centres (FOC) and Retail parks. Together with these elements, we took in consideration also the Entertainment centers (which are sometimes integrated by retail functions) and the cinema multiplexes. Although they are not retail poles, we decided to involve also these specialized aggregated because we considered important attractors, and they produce spatial habits for their users that integrate the retail poles' ones. Therefore, we compared the regional data with many DBs, produced by different players (associations, think thanks, specialized journals, etc.) that provided other kind of information (GLA, number of existing shops, functional mix, brands, etc.) that are not contained within the regional database.

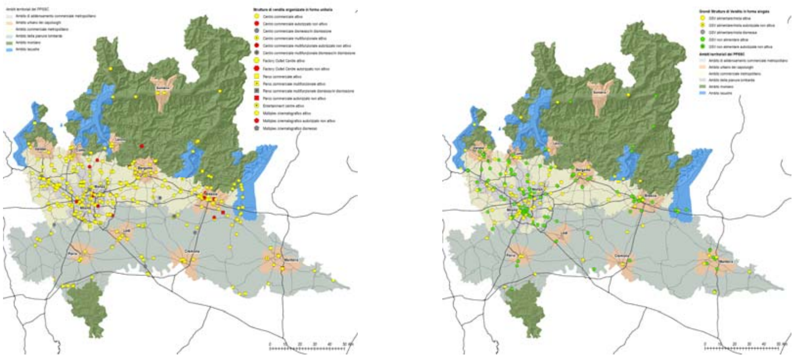

Fig. 4 Retail poles in Lombardy Region: Poles organized in unitary form (left) and large specialty stores (right)

<u>Large specialty stores</u>

Together with the poles organized in unitary form, they appear 228 other structures (221 active, 4 projects and 3 dismanteld/abandoned), organized as large specialty stores with different merchandising offers. Amongst active authorizations, it emerges the role of "Large general merchandise stores", that involved food dealers and supermarkets, and "Furnitures stores", with relevant companies as IKEA and other players.

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[7] https://dati.lombardia.it/

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POLES	AMOUNT	TIPOLOGY	AMOUNT
Active retail poles	309	Shopping malls	198
		Multifunctional shopping malls	19
		Retail parks	73
		Multifunctional retail parks	4
		Factory Outlet Centres (FOC)	2
		Entertainment centre and multiplexes	13
Projects	16	Shopping malls	11
		Retail parks	3
		Factory Outlet Centres (FOC)	1
		Entertainment centre and multiplexes	1
Dismantled/abandoned	7	Poles organized in unitary form	6
		Entertainment centre and multiplexes	1
Total	**332**		

Tab. 1 Retail poles in Lombardy Region: Poles organized in unitary form

POLES	TIPOLOGY	AMOUNT	SURFACE (sq. m.)
Active retail poles and projects	Sportswear and accessories	8	28,070
	Clothing and accessories	38	139,136
	Bricolage	23	137,440
	Large general merchandise stores (hypermarkets, superstores, etc.)	93	343,492
	Consumer electronics	5	20,403
	Department stores	6	59,906
	Furniture	46	270,746
	Dealerships	1	3,163
	Others	5	10,625
Total		**225**	

Tab. 2 Large specialty stores: merchandising mix

Looking at spatial distribution, there is a strong correspondance among retail poles and population density (Cavoto & Limonta, 2015), especially for the metropolitan corridor that links the cities of Milan, Bergamo and Brescia. But other conditions characterize a number of spaces where retail poles show specific settlement practices:

- role of relevant infrastructures and major roads. Therefore, locations along these axis – or better, in their crossroads - maximize the potential attractiveness of the commercial structures (as in pre-alpine valleys, i.e. Val Seriana, Val Trompia, Valtellina);
- tourists' presence, as in the area of Lakes (Garda, Como, Iseo) provides a number of no-resident users for retail poles;
- high competition for local markets where the proximity achieves a strong relevance. In these areas, there is a strong reduction in attractivness – and consecuently, in profitability - for retail poles that brings, in extreme casses, in processes of progresive crisis and dismantling (as in the area of Pianura Padana).

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3.2 DYNAMIC DATA: ATTRACTIVENESS AND VISITORS

Once portraited the spatial distribution of retail poles in Lombardy, we focused on their attractiveness as a relevant variable to define the competitive scenario for the region. In this case, we moved to "dynamic" data, focusing on the power of these spaces to entice visitors, due to their format (that depends to the management skills of tenant/developers) and their accessibility (relationship with infrastructures). This task was aimed to defining a model of the gravitation power of visitors that exceeds the idea of "the largest, the most catching", focusing on their territorial role and taking in account specific characteristics of every poles.

TERRITORAIL ROLE/ ATTRACTIVENESS (DIMENSION)	FOOD	MIXED	NON-FOOD	WHEN THE STRUCTURE FORMS PART OF A RETAIL PARK OR A SHOPPING MALL
Intermunicipal attractiveness (less than 5, 000 sqm)	15′	15′	15′	15′ Shopping malls and retail parks 25′ Multifunctional shopping malls 30′ Factory Outlet Centres (FOC)
Provincial attractiveness (5,001 < x < 10,000 sqm)	25′	25′	25′	25′ Shopping malls and retail parks 30′ Multifunctional shopping malls 40′ Factory Outlet Centres (FOC)
Interprovincial attractiveness (10,001 < x < 15,000 sqm)	35′	35′	35′	35′ Shopping malls and retail parks 40′ Multifunctional shopping malls 50′ Factory Outlet Centres (FOC)
Regional attractiveness (15,001 < x < 30,000 sqm)	50′	50′	50′	50′ Shopping malls and retail parks 60′ Multifunctional shopping malls 70′ Factory Outlet Centres (FOC)
Regional attractiveness (30,001 < x < 50,000 sqm)	70′	70′	70′	
Regional attractiveness (50,001 < x < 80,001 sqm)	80′	80′	80′	
Regional attractiveness (more than 80,001 sqm)	90′	90′	90′	

Tab. 3 Reference isochrone (dimension in minutes) for the calculation of the catchment area of retail poles (Source: Table 1 of Annex 1 of the D.G.R. X / 1193)

Following the definitions proposed by Regione Lombardia in the D.G.R. X / 1193, we define the dimension of the shopping polarities catchment area[8]. Therefore, in the analysis we introduced variables related with context's conditions (density of inhabitants, presence of infrastructures, accessibility, etc.), format (calculating the visitors of every pole - as shown in Tab. 3 – starting from its attractiveness and its relative catchment area).

We carried out the analysis in GIS environment (ESRI Network analysis), where we identified the isochrone for each pole of our sample. We generated these isochrones thought a network model based on the OpenStreetMap (OSM) data released with ODbL license[9]. We calibrated the travel speed of each arc according to the traffic level of the different urban contexts[10] and the network model considers the effect on speed reduction due to the presence of nodes along the network and the effects of acceleration/deceleration of the vehicles between nodes. For the elaboration of isochrones, we assumed an optimal service level (level

[8] The catchment area of every pole has been defined following the indications of Table 1 of Annex 1 of the D.G.R. X / 1193, the regional document that define the extension of the isochrone as a function of format and dimension.
[9] Open Database Licence.
[10] The calibration is based on data of ISTAT Census 2011 about commuting practices by private vehicles (cars and motorcycles).

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A) of infrastructure, without interferences between vehicles that could influence their travel speed. Once completed the simulation, the isochrone could be represented in two ways:

- as a linear element, taking a graph portion equal to the distance travelled by a vehicle in a discrete time;
- as a polygonal-area element, that occupies the hypothetical geographic area equal to the distance travelled by a vehicle in a discrete time.

For the present analysis we choose the representation based on polygonal elements because, in our opinion, allows a more effective representation and a better geographical interpretation. Discussing our approach during the research, we pointed out how the isochrones are products of a simulation produced by an informatic algorithm, and as other spatial representations, there is an implicit risk of oversimplification of the reality and/or its distortion. In this specific case we focus on the oversizing of the geometry of the polygon and, for this reason, we produced a protocol that minimizes the area's approximation of the simulation. Therefore, we limited the area around major infrastructures, that often include portions of territory just partially affected by the attractiveness of a specific retail poles. Using GIS technology, we produced a weight overlay map, that shows the overlays of catchment areas of poles that belong to our sample[11]. The map shows the interactions and overlays between polygonal geometries of isochrones, paying attention to the attractive power of each pole and, therefore, including in this model their relevance as a variable.

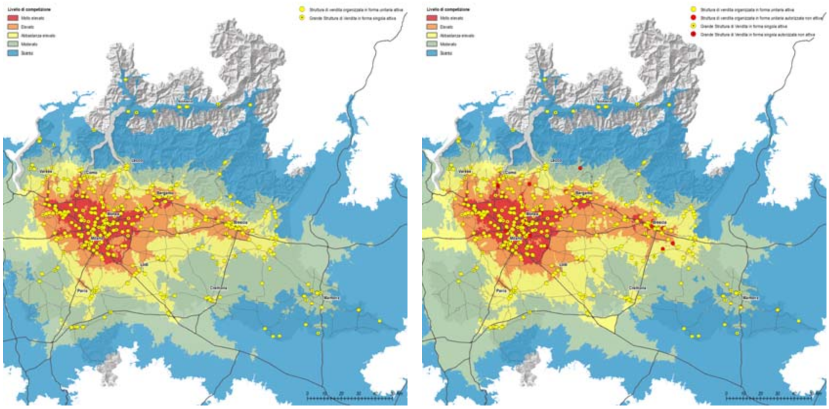

Fig. 5 Overlay of catchment areas of retail poles in Lombardy Region: Scenario 0 – existing poles (left) and Scenario 1 – new openings (right)

In this case, we consider double the attractiveness of poles organized in unitary form compared with large specialty stores. Resulting overlays are clustered in 5 classes through the Jenks natural breaks optimization[12]

[11] We excluded in this phase those poles that are: (i.) dismanteled or in crisis; (ii.) multiplex and entertainment centres, (iii.) those large specialty stores that showed a limited attractiveness (specialized in materiali edili, macchinari industriali, etc.)

[12] This is done by seeking to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means of the other groups. In other words, the method seeks to reduce the variance within classes and maximize the variance between classes. Once the number of classes has been defined, the same are identified in the points of discontinuity of the distribution of values, then the difference between the sum of the square deviations in each class and the sum of the differences with respect to the global average is maximized (Wikimedia Contributors, 2018).

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due to its effectiveness in the classification of values not uniformly distributed. The geographical representation describes the competitive context of regional market (very high, high, moderately high, low, very low), considering the relative proximity of poles with similar formats (horizontal competition) or other offers (vertical competition) and development of ongoing projects (existing competition and a scenario with new openings).

Once obtained the map of the competition among retail poles in Lombardy, we projected the overlays of their catchment areas on administrative structure of region through a process of geo-processing developed with GIS technology.

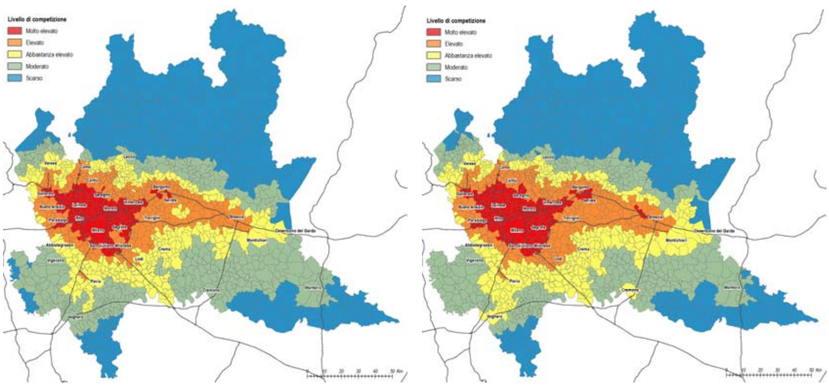

Fig. 6 Classification of Lombardy Region municipalities for competition degree: Scenario 0 – existing poles (left) and Scenario 1 – new openings (right)

Therefore, we obtained a classification for each municipality13, noticing a odd absence of competition on regional boundaries. Therefore, we decided to extend the sample of analysis to retail poles of other regions (Piedmont, Veneto and Emilia Romagna) or nations (Swiss) that have catchment areas that attracting visitors outside the regional market. We found a set of "extra-regional" structures able to attract users because they are located near the regional administrative border (Brunetta & Morandi, 2009) and we integrated the model[14] and the resulting regional classification with this information. These results show the limits of analysis based on static data, that does not take in account the regional competitive context. At the same time, through this approach, we discussed those parameters defined by Lombardy Region in Tab. 1 of Allegato 1, D.G.R. X/1193 (cfr. Tab 3 of this paper). Despite the interesting definition of isochrones according to dimension and formats, resulting model applies these parameters to the whole regional space, without modulating values according to the market competition. We proposed a new protocol, in which the assessment of new openings takes in account existing spatial distribution of retail poles and - through it - definition a more precise rea of influence of these structures. Moreover, this original representation is a useful tool to understanding the attractiveness of retail poles and their spatial impacts and it can be used as

[13] When a municipality belongs to a unique class, we assigned automatically them. When the municipal space belongs to different classes, we assigned the one that occupy the largest part.

[14] We selected 68 Italian and Swiss structures, with more than 10,000 square meters GLA, considering a 30 minutes isochrone for each pole.

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a base to define strategies and actions not only for retail sector but, as in this specific case, to define an original approach to assess those impacts related with large transformations and give hints to evaluate the influences of new openings for infrastructures and private mobility.

3.3 DYNAMIC DATA: QUANTIFYING THE ATTRACTIVENESS

Over the last decade, we worked focusing on the spatial dimension of retail sector, and we assumed that models or algorithm that estimate a priori the attractiveness of a retail structure often over-simplify variables and parameters that influenced consumption behaviors and users' practices of these structures. Despite our distrust for this approach, in the mentioned research we were expected to provide a predictive model based on gravitational ones, to estimate the number of potential visitors of each pole, taking in account those limits and risks pointed out in the section above. Recent studies show several econometric approaches to these estimations, with different degree of complexity and precision. Starting from the Huff-model (Huff, 1964) and its evolutions (Gonzalez-Benito, 2005; Simmonds & Feldman, 2011) economists involved a Newton Gravitation Law in economic analysis and assume that the probability to choose a destination shopping decreases with the distance and increase with the size of the structure (Reilly, 1929). This approach is normally used as a representative element of attractiveness. Our aim was different from the general target of those models, that try to estimate the attractiveness of a specific location. We were called to give a tool for public authorities, that should evaluate impacts on infrastructure networks. Therefore, our model involves the same variables and parameters of gravity models but is different in terms of application and goals.

Therefore, we define an isochrone following regional guidelines, taking in account a reduction in terms of time (and, consequently, area) due to the existing competition. Together with this first isochrone, we defined also intermediate ones, every 5 minutes, and we consider the areas of each municipality involved with this subdivision. The aim of this task is defining the footfall (visitors per year) and for this operation, once identified the population living within this area, we reduce the number of potential visitors taking in account the competition degree[15] and consumption behaviors[16] for each municipality within the catchment area. The validation of this approach is verified comparing values obtained following the protocol described with real data about visitors per year of a sample of Lombardy poles organized in unitary form[17] provided by management companies of malls or from National Council of Shopping Centers (CNCC, 2017). This comparison highlights the relative reliability of this model for standard cases but its limits where the position of a specific localization or its features maximize its potential basin and, so, figures out a number of potential visitors very high but the real footfall is lower. In these cases, the deviation between real and estimated values is higher than 90%. In a "traditional" gravity model operators should analyze in deep competitors and spatial distribution of existing retail poles to starting this operation.

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[15] For this reason, we multiply the values of the resident population (potential basin) with a percentage parameter defined starting from the class of competition assigned to each municipality, and we obtain the number of inhabitants that – hipotetically – could choose a specific structure among the offers that they have in a local context.

[16] We defined an "annual frequency coefficient" that takes in account the distance from the retail pole, and that describe the propensity of a inhabitant to visit a specific structure due to the travel time needed to get there. We applied this coefficient to the population of each 5 mins. Isochrone: 0-5 mins: 104 (2 visits/week); 5-10 mins: 78 (1,5 visits/week); 10-15: 52 (1 visit/week); 15-20 mins: 36 (3 visits/month); 20-25 mins: 24 (2 visits/month); 25-30 mins: 12 (1 visit/month); 30-35 mins: 4 (4 visits/year); more than 35 mins: 2 (2 visits/year).

[17] Sample analyzed constitutes to 45 structures organized in a unitary form able to offer a homogeneous coverage of the regional territory.

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In this light, and excluding limiting cases, this approach estimates footfall for retail poles with an appreciable degree of precision, especially considering that our aim was the definition of attracted flows and their impacts on infrastructure networks.

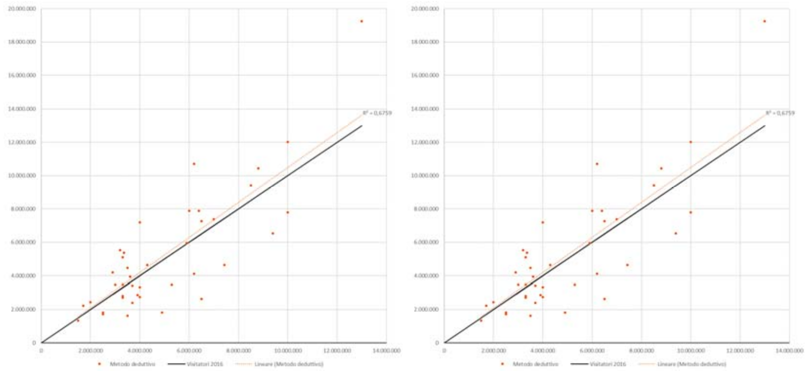

Fig. 7 Deviation of the values calculated respect to the visitors registered: with borderline cases (left) and without the borderline cases (right)

3.4 DYNAMIC DATA: DISTRIBUTE THE ATTRACTIVENESS GENERATED. THE INTEGRATION WITH GOOGLE PLACES DATA

For the reasons mentioned above about the final aims of the research that we present in this paper, we were asked to foster the analysis about the rate of the flows generated by those poles and to define a methodology able to describe the users' attendance habits of these structures.

We discarded the hypothesis of a work based on direct survey that, although precise and commonly used for specific analysis, was impossible to extend to the whole sample of 557 identified poles. Therefore, we looked for a reliable and transversal source of data that allows to make comparisons and details on the distribution of the weekly attendance of single poles. This means that we looked for an effective and not expensive (due to the lack of financial and human resources to invest in this phase) process of data mining for these data. Amongst data sources available for free, we explore the information related with the service Google Places.

Fig. 8 Google Places: Data related with users' attendance of a specific structure

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Google search engine displayed these data in the "Maps" web service and the "Search Results" page. They should support users in programming a visit to specific places, giving hints about crowding level of the structure, real time presences and an estimate of the average duration of the visit according to the day of the week.

Once defined the process of scraping of these data, we focus on a sample of 57 poles (28 organized in unitary form and 29 large specialty stores) focusing on different typologies, in coherence with the regional categories defined taking in account their degree of attractiveness (Tab. 3). To make comparable these data, we selected among structures that give the total amount of visitors over the year and thanks to these information, we could elaborate the extracted data from Google.

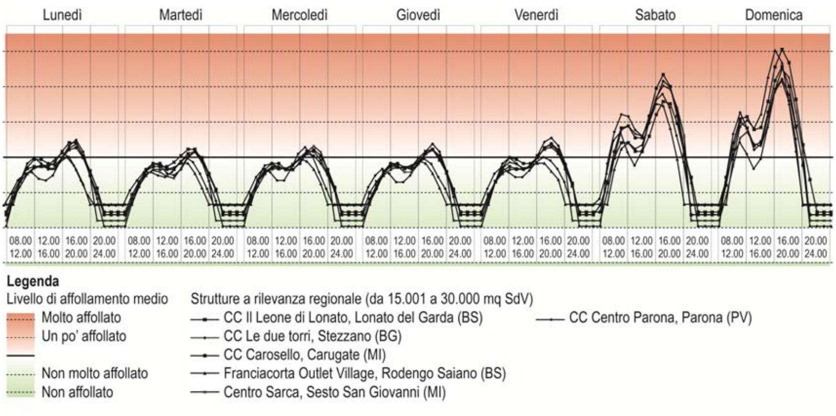

Fig. 9 Attendance profile of poles with regional attractiveness (15.001 < x < 30.000)

For every typology, we collected examples to deal with the complexity of the system, selecting both central and peripheral structures, as well as paying attention to their accessibility and their formats. Finally, we defined attendance profiles for both Poles organized in unitary form (Fig. 8) and Large specialty stores (Fig. 9), pointing out which days are more crowded during the week (Tab. 4) and those rush hours (Tab. 5) that could affect on infrastructures' normal work.

4 CONCLUSIONS: TOWARDS A DETAILED AND USABLE SPATIAL KNOWLEDGE FOR POLICY MAKERS AT REGIONAL SCALE

Within the present contribution we proposed an example in which a variety of methodologies and data have been involved to describe the retail poles distribution in Lombardy space, and the current condition of this Region as a mature context mature and high-competitive market. Our analysis exceeds descriptive images and tried to point out the attractive characteristics of every pole and the impact of the resulting system in terms of attraction for local populations and potential externalities on infrastructures.

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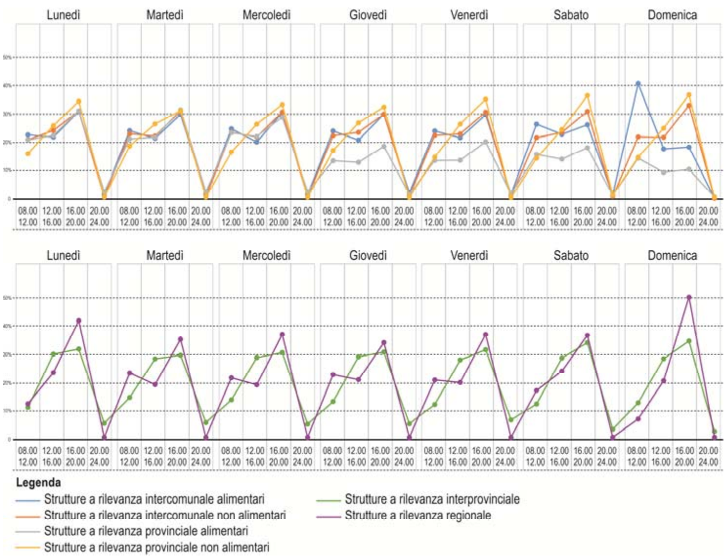

Fig. 10 Attendance profile of large specialty stores

TERRITORAIL ROLE/ ATTRACTIVENESS (DIMENSION)	Most crowded week day			Most crowded week end day		
	Day	Time	% on whole day	Day	Time	% on whole day
Intermunicipal attractiveness (less than 5,000 sqm)	Friday	17:00-18:00	12.2%	Saturday	17:00-18:00	11.9%
Provincial attractiveness (5,001 < x < 10,000 sqm)	Friday	17:00-18:00	12.7%	Saturday	17:00-18:00	16.0%
Interprovincial attractiveness (10,001 < x < 15,000 sqm)	Friday	17:00-18:00	11.4%	Saturday	17:00-18:00	17.3%
Regional attractiveness (15,001 < x < 30,000 sqm)	Friday	18:00-19:00	11.0%	Sunday	17:00-18:00	21.00%
Regional attractiveness (30,001 < x < 50,000 sqm)	Friday	18:00-19:00	10.5%	Sunday	17:00-18:00	28.2%
Regional attractiveness (50,001 < x < 80,001 sqm)	Wedensday	17:00-18:00	11.1%	Sunday	17:00-18:00	26.9%
Regional attractiveness (more than 80,001 sqm)	Wedensday	17:00-18:00	10.9%	Sunday	16:00-17:00	28.9%

Tab. 4 Poles organized in unitary form: Rush hours per week

This approach to the spatial distribution of retail poles is innovative because:

- it provides a vision that embraces the regional scale, considering the interactions and mutual influences between different poles and with their specific contexts (the metropolitan sector that connects the city of Milan, Bergamo and Brescia, the Northern mountains and the Southern plateau marked by low densities and some medium city, the intermediate territories, where stand-alone poles integrate the offer of central functions in consolidated urban cores);

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- it overcomes conventional analysis based on gravitational models, considering variables related with retail poles (dimension, format, functional integration, etc.) that show a deeper and more sensitive know-how about retail and its dynamic and with specific conditions of local contexts (relation with infrastructure networks, visit duration, frequency of visits, behaviors of visitors estimated with the presence of competitors, etc.) that affect a variety of field and sectors (mobility, economy, sociology, etc.). The result is a spatial interpretation more detailed and comprehensive than traditional market tools, because it considers interactions, synergies and – often – contradictions of settlement strategies of retail operators but, at the same time, it takes in account those factors that they use as criteria within their decision-making processes;
- estimations developed with our approach could be improved by exploiting the potential of big data (Manfredini et al. 2016; Pucci et al., 2015), that can be involved to define the effective attractiveness of the commercial polarities analyzed and to evaluate the real distribution of visitors' flows at different times of the day and the week;
- it has been involved in a decisional process of Regional Authority (*DG Territorio e Protezione Civile*) for the definition of new regulations about traffic impacts of large transformations. This example shows how non-conventional and interpretative readings of spatial complexity became useful tools for the definition of a territorial governance.

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GEOSIMULATION METHODS FOR SETTLEMENT MORPHOLOGIES ANALYSIS AND TERRITORIAL DEVELOPMENT CYCLES

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ABSTRACT

The urbanization of recent decades has radically changed the original morphology of territorial systems. Recognize the traces of long-term urban form, on a large scale, can help land planning actors in order to make settlements more sustainable and resilient. The aim of the paper is to analyze the long-term urban plan for the territory of Albenga area, in the Western Liguria, Italy. Settlements are analyzed together with the basic territorial structures that have generated them during the historic long period. The study starts from the diachronic reading of cycles of territorial development that have gradually formed the present settlement. The matrix elements that determine the shape of the settlements are, in the first instance, the paths and the plots (including land uses), detectable by comparing different historical maps. Subsequently the different built forms are classified into "morpho-territorial typologies". The representation of the settlement into different temporal stages is the result of processing carried out through the use of GIS and simulation models based on cellular automata and multi-agent systems. Through geosimulation techniques it is possible to rebuild both the process of formation and transformation of the settlements, and to represent the structure of long-term of "morpho-types". The use of geosimulation techniques also allows the construction of scenarios in which it is represented how the process of urbanization of the last 50 years has radically altered the original settlement structures and also allows us to represent the possible evolutions of the settlement system.

KEYWORDS

Spatial Modelling; Territorial Cycles; Geosimulation; Cellular Automata

1 INTRODUCTION

1.1 THE MAIN ISSUES CONCERNING THE RESEARCH

The main purpose of this contribution is to understand and represent the current territorial structures (settlement fabric), characterized by a post-metropolitan condition. The research attempts a description of a post-metropolitan territory, trying to highlight some salient features that, according to E. Soja can be identified in a poly-nucleated urbanization, a frequently absence of dominant centers, settlement dispersion / diffusion, fragmentation and segregation of uses. The hypothesis carried out by the research is that the territory can be analyzed as the stratification of successive settlement cycles (according to Muratori and Caniggia). Then the question is to understand territorial change and how to represent it. Another hypothesis concerning the role that physical space play in determining settlement forms. The research is based on the idea that human settlement, in its historical evolution, is conditioned by the physical and morphological characteristics of the territory, as well as by the quantity and quality of environmental resources. The creativity of human activities (technology, civil development, aesthetic aspirations) creates the special symbiosis between man and environment that characterizes every human environment. Moreover, the history of the settlement is the story of the continuous and changing adaptations that the anthropic structure (in its material and cultural dimensions) operates towards the stratifications inherited from the precocious ages. In this sense, the history of the settlement can be interpreted as the succession of a series of cycles over time, in which, in every age, original equilibrium relations are manifested between local communities, environment and resources. Another question is, then, how the 'sediments' left by previous cycles are used and/or reused. Similarly, the research the research tries to understand. What are the relationships between economic and social cycles and settlement territorial cycles. Here, the hypothesis is if it's possible to think a method that knows how to understand the territorial settlement cycles as a path dependent process, but at the same time in an innovative way.

1.2 THEORETICAL ASSUMPTIONS: TERRITORIAL CYCLES AS INTERPRETATIVE KEY

The post-metropolitan territory (and the territory in general) can be read as a succession of cycles of territorial settlement. The material history of the territory is the history of the forms of its settlement and is not linear, but it's characterized by cycles of innovation / consolidation, centralization / dispersion, employment / abandonment, colonization / restructuring. Sometimes these settlement dynamics act simultaneously (they are synchronous), in other cases they alternate over time and are differentiated in space (diachronic changes). The geographical space (the physical and morphological characteristics of the territory), condition the different territorial cycles (above all the first cycles) that are always the result of an uncertain and unstable equilibrium between population and environmental resources. The forms of settlement inherited from the past also condition future developments, sometimes posing as constraints sometimes as opportunities (reuse of previously shaped structures).

1.3 THE METHOD ADOPTED

The most recent land use/cover change models (Briassoulis, 2000; Basse et al., 2014; Batty, 2015; White et al., 2012) are usually based on different empirical techniques (e.g., artificial neural networks, agent-based models, genetic algorithms) or statistical techniques (e.g., multi-criteria analysis, regression models) and

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underlying theories have significantly increased researcher's interest because they can (1) explore dynamic processes of the land use system; (2) build models of relationship among changes and spatial and non-spatial variables; (3) can make explicit the weight and the role that the different variables taken into account have in determining the changes in land use; (4) predict future land use development over space and time; (5) simulate trajectories of land use changes and feedback loops through the implementation of land use scenarios. For the study of the succession of the different territorial cycles, the starting information base was constituted, by the analysis of changes in land use and land cover. Through the reading and analysis of variations in land use maps it is indeed possible to elaborate a description of the spatial structure of the settlement. The land use maps developed in this way are then the basis for developing simulations on possible future territorial structures. The method adopted allows to represent the dynamic settlement structure of a territory in an historic way, allowing to describe and observe the phenomena of centralization / dispersion, occupation / abandonment, colonization / restructuring.
Briefly, the workflow consists of the following steps:

- obtain landcover map for few time slices and a set of potential explanatory variables;
- calculate probabilities of transitions from class to class;
- build a model using ANN, logistic regression, Weights of evidence or Multi-criteria evaluation to describe transitions based on factor variables;
- use this model for forecasting;
- validate the result with real data.

More precisely, the proposed method consists of six processing steps (Tab. 1):

Elaboration of data sets and land use and land cover maps in different time stages	Institutional open data maps, image interpretation of aerial photos, survey on site, GIS
Searching of the potential spatial variables	Spatial analysis thrugh GIS
Evaluation of the statistical correlation between land use change and explanatory spatial variables	Spatio - statistical indices: Pearson's correlation
Modeling the temporal transition rules between the different land use maps	Artificial Neural Network (ANN) (Multi-layer-perceptron)
Simulation of change through geosimulation methods	CA- Cellular Automata
Calibration and validation of the model results	CA- Cellular Automata

Tab. 1 Spatial analysis of territorial cycles: steps of the proposed method

2 THE STUDY AREA AND THE ANALYSIS OF TERRITORIAL CYCLES

The study area concerns a western region of Liguria (Albenga and its region), characterized by the presence of an important coastal plain that has been formed, from a geomorphological point of view, from the confluence of some mountain streams. It is one of the few flat areas of Liguria and its shape has influenced the forms of settlement over the centuries. The history of human occupation in the area is very ancient and even in Roman times the area was characterized by an intense process of colonization. The vivacious agricultural and productive characteristics have been maintained and consolidated, up until today.
Albenga is an area of ancient human colonization. We can recognize almost fuor phases of human territorial occupation. The first phase of settlement structure (3.000-2000 years ago) is characterized by the presence of small residential areas on the heights, near the ridges (centers of the promontory). The second phase of

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settlement evolution is characterized by the descent towards the valley of the settlements and by the progressive occupation of the hillsides. This is the period in which large terraces are built and it is the period in which agricultural production consolidates itself and specializes. The paths now descending from the ridges become mid-way routes. The first long-distance foothills paths are also built. The third phase is characterized by the intensive occupation of the lowland areas of the valleys. The agricultural structure now occupies all the flat coastal areas and the valleys, thanks to the drainage of previously swampy areas. The road network becomes dense and even urban centers rise in rank (population, markets, activities). In this period (1300-1950) also begins a phase of organization of the territory that focuses on some new foundation urban centers. The fourth phase coincides with the urbanization process of the modern era.

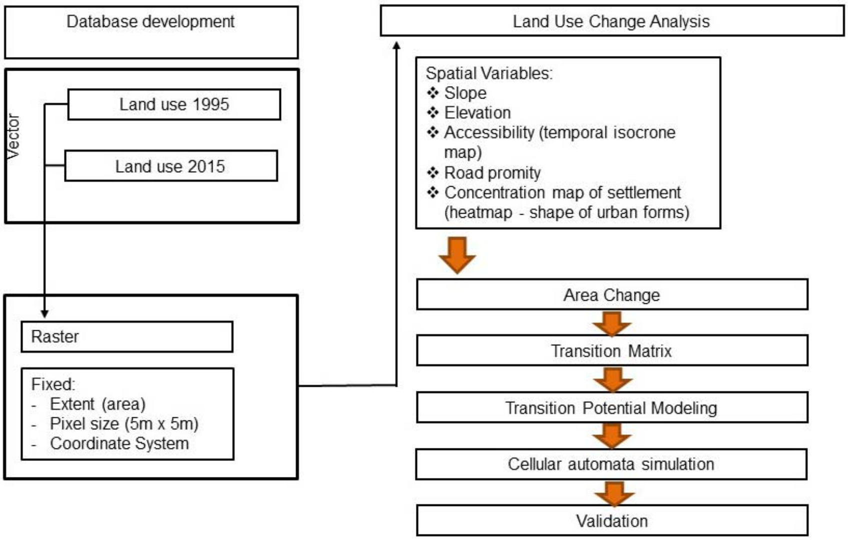

Fig. 1 The phases for the development of land use change model

On the basis of the settlement structures built in previous periods, the agricultural activity becomes more and more intensive (industrialized agriculture) and this primary activity is flanked by various other functions such as trade and industry, which tend to occupy large areas with increasingly large building artifacts.

About modern settlement dynamics, we can recognize three phases in the last 60 years. The first phase of the modern era (1950-1975) is characterized by the strong presence of traditional agriculture conducted on small plots. Production is concentrated mostly on fruit and vegetables and the outlet market is mainly local. The other activities (which materialize themselves in specific uses) are weak, except for the residential function that emerge in strong increase during this period. The population is increasing (from 12,000 to 19,000 inhabitants). The second period (1975-1995) is characterized by a strong conversion of agricultural activity towards industrialized production forms with great growth of greenhouse plants and specialized crops. Agricultural activities are now flanked by the productive and commercial functions (often entering into competition with the agricultural land uses) that tend to occupy great spaces, especially near the main roads. The quantitative growth of the building continues. The population continues to increase, but at a

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slower rate: from 19,000 to 21,000 inhabitants. The third period (1995-2015) is characterized by a strong expansion of service industry, productive and commercial functions to the detriment of agriculture. The more specialized agriculture resists and consolidates itself, but the agriculture conducted in more extensive forms, on the one hand is replaced by new urban activities (increasingly widespread in the territory), on the other side is subject to abandonment, with the consequent growth of forest and natural areas. Building development is remarkable and even the population continues to increase (from 21,000 to 23,000 inhabitants). To investigate what were the main trends in the transformation of the territorial structure of the case study area in the recent past, it has been hypothesized that a fundamental tool of knowledge is constituted by the analysis of changes in land uses over time. In fact, an anthropized territory can be read as the organic overlap between a structure of land uses, a subdivision plot and settlement morphologies. Undoubtedly the mosaic of land uses is the one that most conditions (and is in turn conditioned) the other two components. Therefore, reconstructing the succession of changes in land use over the medium to long term allows us to provide a cyclical reading of territorial evolution. The modifications that can be read in the physical structure of the territory can also be linked to the more general socio-economic dynamics of the study area, also characterized by strongly cyclical trends. In particular, the cycles of change in land use destinations (the role of agriculture, the crisis of traditional agriculture, the dynamics of abandonment of the higher areas, the growth of dispersed urbanization, the increase of tertiary functions) can, in a broader perspective of research, link to some general scenarios such as: continuity of current trends, growth of innovative agricultural activities, growth of tertiary activities, consolidation of the residential function. In this contribution we will illustrate the scenario of continuity of current trends.

3 OPERATIONAL STEPS FOR LAND USE SIMULATION

The land uses used in this study were vector data and classified into 8 categories: compact residential, other urban uses, dispersed settlement, urban green areas, intensive and extensive agriculture, forest and natural areas, water. Most of spatial variables were loaded in vector format, where the MOLUSCE deals with raster data. So, first thing was to convert all vector data to raster data to be able to deal with plugin. Other terms to deal with plugin is to set the same coordinate system for all layers. Applied resample process for all layers to determine the same pixel size, in this study the pixel size chosen is 5x5 mt.

<u>1° step - Inputs - Data preparing</u>

The initial (period 1, 1995) and final (period 2, 2015) land use/ land cover maps as well as spatial variables such as slope, road proximity, elevation, and settlement density and form are loaded in the panel of spatial variables (Fig. 2). The land use/ cover change information and the spatial variable are been used for modeling and simulating land use/ cover changes in area-studio. In this step, it was crucial checking geometry if all inputs matched (pixel dimension, coordinate systems, scale and so on).

<u>2° step - Evaluation correlation</u>

This step comprises three methods, namely the person's correlation, joint information uncertainty, and crammer's coefficient, which are used to check correlation among the spatial variables. The analysis (Tab. 2) shows the correlation ratio between the five variables (slope, road proximity, elevation, built concentration and accessibility -isocrones-). It is noticed from the result that the slope and elevation layers are inversely related to the other variables, which are inversely affected. The roads often need an equal area in order to facilitate street construction. The other variables are linked by direct links.

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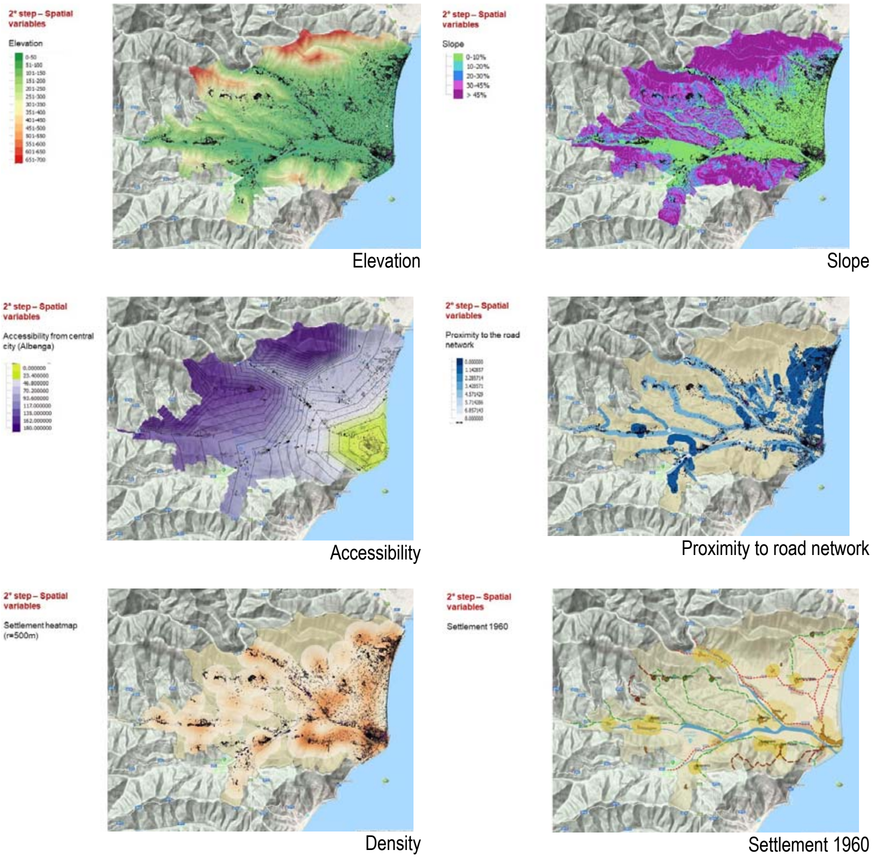

Fig. 2 Spatial variables selected

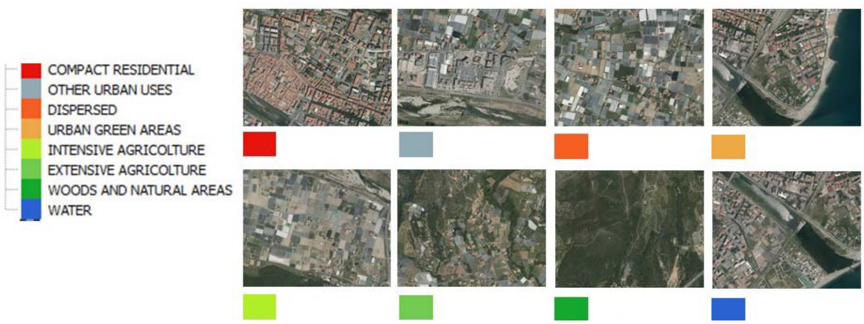

Fig. 3 Land uses categorization

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VARIABLES	Proximity	Accessibility	Slope	Elevation	Density	Form
Proximity road network	---	0.152	0.102	0.122	0.120	0.431
Accessibility to central city		---	0.507	0.613	0.537	0.356
Slope			---	0.635	0.372	0.238
Elevation				---	0.438	0.421
Settlement density					---	0.539
Settlement form						---

Tab. 2 Pearson's correlation among spatial variables

3° step - Area change

In this tab, land use/ cover change (Fig. 4) and transition probabilities are computed. Also land use/ cover change map produced. The land use/ cover units have been expressed in hectares.

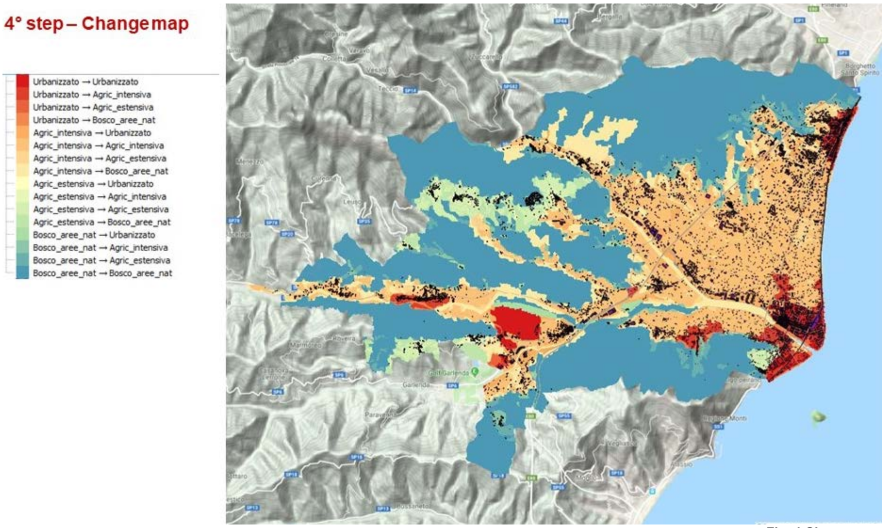

Fig. 4 Change map

4° step - Transition potential modeling

The method for computing transitional potential map is Artificial Neural Network (ANN). This method uses land use/cover information and the spatial variable as inputs for calibrating and modeling land use / cover change. The resulting data show the correlation ratio between the six variables (slope, road proximity, elevation, built concentration and accessibility -isocrones-). It is noticed from the result that the slope and elevation layers are inversely related to the other variables, which are inversely affected. The roads often need an equal area in order to facilitate street construction. The other variables are linked by direct links.

5- Cellular Automata simulation:

To build simulation maps, Molusce uses as a method of projection (among others) a neural network. In order to develop a network with adequate predictive capacity, it was necessary to train and test the ANN with different input data. Training involves presenting input values and adjusting the weights applied at each node according to the learning algorithm (e.g. back-propagation). ANNs were applied to the prediction of

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land use change in four phases: (1) design of the network and of inputs from 5 spatial variables and a spatial historical map; (2) network training using a subset of inputs; (3) testing of the neural network using the full data set of the inputs; and (4) using the information from the neural network to forecast changes. Transitional potential map (Fig. 5), certainty function, and simulated land use/ cover maps are generated under this process. The cellular automata approach is based on Monte Carlo algorithm.

Fig. 5 Transformation potential and sinulation of land use at year 2040

<u>5° step - Simulation</u>

The MOLUSCE plug-in provides the tools to conduct an analysis of transformation potentials. In fact, starting from the change maps, the system "learns" through the ANN which are the highest probabilities, for each pixel, of permanence of the present land use or of its variation (and in which direction this variation might take place). The rules that are built through the ANNs consider the spatial variables that influence changes and their weight. Through other tools, such as multi-criteria analysis or logistic regression, we could also build different hypotheses of relevance (correlation) between the spatial variables considered and the process of change in land use. All these techniques can lead to a progressive refinement of the model's ability to predict potential future uses with an increasing accuracy.

<u>6° step - Validation</u>

Validation computes Kappa statistics (standard kappa, kappa histogram, and kappa location), misses and false alarms are produced under this component.

In order to predict future trends and change in the study area, we have been used transitional potential modeling (ANN) combined with Cellular Automata to forecast future changes in LU-LC between 1995 and 2015. The result indicates that the probabilities of increasing area will be cover by settlement and forest areas (development vs abandon), and a relative permanence of intensive agriculture. In order to predict future trends and change in the study area, we have been used transitional potential modeling (ANN) combined with Cellular Automata to forecast future changes in LU-LC between 1995 and 2015. The result indicates that the probabilities of increasing area will be cover by settlement and forest areas (development vs abandon), and a relative permanence of intensive agriculture. About the analysis of changing land use, the land use forecast map elaborated with the combined system of ANNs and cellular automata, clearly shows how, in the scenario of the persistence of the current trends, the opposing dynamics of over-use and abandonment will be further developed in the next 25 years. While in some areas already historically urbanized or with strong and consolidated presence of agricultural activity we will observe phenomena of substantial persistence of uses, in the fringe areas we will alternatively will observe phenomena of further settlement development or abandonment phenomena with the advance of the forests and natural areas.

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4 CONCLUSIONS

The Land Transformation Model presented in this paper examines the relationship between 5 predictor spatial variables and land use changes. The model performs with a relatively high predictive ability (46%) at a resolution of 5x5 mt. By developing 5 versions of the LTM, each with one of the variables removed, we could assess the relative contributions of each variable on model performance. Similarly, if we set up simulations according to a different set of (spatial) variables (one set for each scenario), we could obtain different forecast results, processing a real scenario analysis. A set of alternative scenarios could then form the basis for carrying out preferential analyzes with multi-criteria methods.

Using the ANN pattern file generated for the study area, we've applied the network file created from the control run to create a file with changing likelihood values for each location in the entire area. In order to obtain a reasonable result, we made several assumptions. First, we assumed that the pattern of each predictor variable remained constant beyond all the period. Spatial rules used to build the interactions between the predictor cells and potential locations for transition are assumed to be correct and constant over time. Third, the neural network itself was assumed to remain constant over time. Thus, the relative affect of each predictor variable is assumed to be stable. Finally, the amount of urban per capita undergoing a transition is assumed to be fixed over time. Given the availability of data (e.g. new roads, more temporal information about land use change and other variables), it is possible to relax many of these assumptions in order to examine the potential effect each of these assumptions have on the performance of model forecasts. In general, the simulation model is able to represent forms and dimensions of the change in land use and therefore the settlement structure of the area, highlighting what could be important trends in the near future, where the size of the dispersed settlement will go probably growing up.

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CLIMATE CHANGE AND COASTAL CITIES

A METHODOLOGY FOR FACING COASTAL FLOODING

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ABSTRACT

Coastal cities represent the main vulnerable areas to the climate change impacts (especially to coastal flooding) because of the high concentration of people and economic assets that will are foreseen to increase in 2100. Since cities are important sites of global climate actions, urban planning plays a key role in the climate change challenge. In particular, the definition of urban adaptation strategies requires the adoption of a systemic approach. Through such an approach, indeed, it is possible to consider in a holistic way all elements, which affect the urban resilience of coastal areas to climate events, such as coastal flooding. However, the literature review and the analysis of urban planning experiences have shown that procedures for assessing the resilience level of coastal cities and tools for addressing decision-makers to implement resilient policies and actions in these areas are not well established. Therefore, the aim of this work is the introduction of a methodology based on a systemic approach for providing urban planning actions in order to improve the resilience of more exposed urban areas to coastal flooding. The proposed methodology takes into account the need to be implemented in a GIS environment to a case study. Moreover, it can be a useful tool for supporting the definition of urban adaptation strategies in relation to coastal flooding impacts.

KEYWORDS

Climate Change; Coastal Cities; Systemic Approach; Adaptation; Coastal Flooding

1 INTRODUCTION

Climate change represents one of the main future challenges at the urban level and cities are still facing its impacts. In this perspective, urban areas are recognized as vulnerable places but they also lead the climate action both at the global and local level. Therefore, spatial planning plays a key role in tackling climate change within the wider sustainable development perspective (Papa et al., 2015; Salata & Yiannakou, 2016).
Considering the worst Representative Concentration Pathway (RCP) by the International Panel for Climate Change (IPCC), for 2010 the mean global temperature could pass 1.5°C, involving several effects such as variability in intensity and frequency of rainfall and sea level rise, among others. In particular, in accordance with the IPCC scenarios sea level could raise in a range between 0.26-0.55 m (for the low emissions RCP 2.6 scenario) and 0.52-0.98 m (for the highest emission RCP 8.5 scenario) (Stocker et al., 2013). Therefore, coastal cities can be considered the most vulnerable urban areas: on one hand, coastal cities are characterized by high concentration of people and economic assets; on the other hand, these areas are potentially exposed to all the impacts of climate change, including coastal flooding. Indeed, future coastal flooding events will become more frequent and severe due to both the sea-level rise phenomenon and storm surges. As highlighted by the European Commission (2013), damage costs are estimated at about €25 billion annually if adaptation will be not implemented in coastal areas.
In light of the above considerations, it appears increasingly clear that it is necessary to adapt coastal cities to make them more resilient to future flooding and guarantee a good quality of life and livability in the coastal urban communities. However, those cities are complex also due to the intersection of two different environmental contexts, land and sea. This complexity requires the adoption of a holistic approach, which considers all the factors of a coastal response to the flooding stimuli.
Currently, urban studies on adaptation of coastal cities are still few and mainly based on the vulnerability assessment. Such approach can have several limitations in relation to the definition of effective urban measures because of its sectorial nature. Indeed, it considers some specific aspects of the urban system (mainly, geo-morphological and social ones) and does not include other important characteristics, including the distribution of the urban activities or the urban layout.
However, the introduction of a resilience-based approach is becoming more common in urban planning and it seems to be more in line with the need to adopt a holistic approach in the challenge of climate change (De Gregorio Hurtado et al., 2015). Unfortunately, the spread of "resilience" definitions in literature represents a relevant limitation for its effective application, especially, in the development of tools for supporting the decision-making process of urban adaptation, particularly in complex urban contexts such as coastal cities. In detail, the vulnerability assessments and the definition of urban adaptation actions still represents two separate phases of the urban adaptation process, while their integration can represent an effective support in the definition of urban strategies in order to improve the whole urban resilience.
In the light of this, this paper illustrates a methodology for support decision-makers in the definition of urban transformations able to improve the resilience of the urban coastal system in case of coastal flooding events through the adoption of a systemic approach.
This contribution is composed of two parts. The former provides a review about the main studies on the topic and the main actions defined in adaptation strategies of coastal cities. Grounding on this, the latter describes the developed methodology and illustrates the preliminary results obtained by its application.

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2 STATE OF THE ART

In the last ten years, several studies have been developed for analyzing the relationships between cities and climate change impacts. In particular, urban studies gave a particular attention to analyze the relationships between urban areas and some specific climate change impacts due mostly to the increase in global mean temperature and the variability of precipitation pattern.
Urban studies on sea-level rise (in general, coastal flooding) and its urban impacts, instead, are few. Indeed, although coastal cities play a strategic role at the territorial level (Nicholls et al., 2018) and represent the most exposed urban areas to the effects of climate change, scientific studies about these areas are mainly sectorial and consider coastal flooding impacts from a geomorphological and/or socio-economic perspective.
In particular, from the analysis of the scientific literature, it emerged that the main studies on this topic concern the coastal vulnerability assessment based on the development of composite vulnerability indices.
Even if these indexes have a similar denomination, they take into account different aspects of coastal vulnerability.
According to Zanetti et al. (2016), it is possible to identify three different approaches to the vulnerability concept for the construction of composite indices in relation to the used variables that are:

- the *geophysical approach*, which is focused on geographical characteristics of the coastal area;
- the *social approach*, which is based on the socio-economic characteristics of the coastal community;
- the *socio-environmental approach*, which summarizes characteristics of geophysical and social approches.

VULNERABILITY APPROACH	INDEX NAME	AUTHORS	SCALE
Geo-physical	Coastal Vulnerability Index (CVI)	Gornitz et al., 1991	Regional
	Sensitivity Index (SI)	Shaw et al., 1998	Regional
	Coastal Vulnerability Index (CVI)	Thieler & Hammar-Klose, 1999	Regional
	Coastal Sensitivity Index (CSI)	Karymbalis et al., 2012	Regional
Social	Social Vulnerability Index (SoVI)	Cutter et al., 2003	Regional
	N.A.	Wu et al., 2002	Regional
	Place Vulnerability Index (PVI)	Boruff et al., 2005	Regional
	N.A.	Li & Li, 2011	Regional
	Coastal City Flood Vulenrability Index (CFFVI)	Balica et al., 2012	Urban
	Socio-Environmental Vulnerability Index for a Coastal Areas (SEVICA)	Zanetti et al., 2016	Local

Tab. 1 Vulnerability Indices in relation to coastal flooding

As shown in Table 1, the concept of coastal vulnerability, initially based on the evaluation of geophysical characteristics, progressively has integrated the socio-economic characteristics. Indeed, some studies (e.g., Cutter et al., 2003) highlight the relevance of social factors in relation to the vulnerability of urban areas, such as the measure of the ability of communities to respond during an extreme climate event. Such ability also depends by the maintenance state of built environment.
According to Balica et al. (2012), the choice of the variables is strictly influenced by data availability and spatial scale of reference (McLaughlin & Cooper, 2011). Indeed, the majority of vulnerability indices were

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developed for a regional level (see Tab. 1), while vulnerability indices for the local level are few (i.e. Zanetti et al. 2016). In general, the evaluation of vulnerability at local level can contribute more effectively in the definition of urban adaptation actions in coastal areas in comparison with the indices developed to be used at the regional scale.

Moreover, since indices have been developed for measuring the vulnerability of coastal areas, most of them are not able to support directly decision-makers in the definition of the urban adaptation actions for improving the responsive capacity of an urban area to a flooding event. Hence, in order to understand which urban adaptation actions could be implemented in coastal cities exposed to flooding impacts, five urban adaptation plans were analyzed (Tab. 2). They were chosen considering their innovation and the strategies adopted after a catastrophic event (e.g. New Orleans and New York) and the plans adopted to prevent likely extreme events, in particular coastal flooding.

CONTINENT	CASE STUDY	ADAPTATION PLAN/STRATEGY	YEAR
America	Boston	Climate Ready Boston	2016
	New Orleans	Greater New Orleans Urban Water Plan	2013
	New York	One New York. The Plan for a Strong and Just City	2015
	San Francisco	San Francisco Sea Level Rise Action Plan	2016
Europe	Copenaghen	Copenhagen Climate Adaptation Plan	2011
	Rotterdam	Rotterdam Climate Change Adaptation Strategy	2013

Tab.2 The analysed adaptation strategies

Based on possible forecasts, adaptation plans/strategies provide a series of urban adaptation actions in order to develop specific measures at the local level. In general, from the analysis of these plans and strategies, it is possible to identify three categories of adaptation actions in relation to the spatial level of reference. It is possible to distinguish:

- *Punctual actions*, which include all the actions referred to the building scale;
- *Linear actions*, which refer to infrastructure interventions;
- *Land actions*, which are related to the new urban developments or urban redevelopments.

In particular, there is a wide spread of *Punctual* and *Linear actions* even if *Land actions* are characterized by a more complexity of interventions. However, all the categories include actions that are related to integrate natural elements (Natural-Based Solutions) in the built environment in order to increase urban resilience (Pelorosso et al., 2018).

Finally, the analysis of the indices developed and the urban adaptation plans and strategies shows that tools are not still capable to address urban transformations in coastal urban settlements in relation to the impacts of coastal flooding. One of the reasons of this gap is due to the wide use of a vulnerability-based approach to face such issue and, consequently, the adoption of a sectorial approach mainly referred to social and geomorphological features, while urban planning requires a more holistic approach for developing effective urban transformations (Papa et al., 2014).

3 DEFINITION OF A METHODOLOGY BASED ON THE SYSTEMIC APPROACH

The methodology was developed according to the General System Theory (von Bertalanffy, 1969) that has been widely applied to the analysis of urban phenomena (Gargiulo & Papa, 1993). According to this

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approach, a coastal city can be interpreted as a system that is composed of four sub-systems: socio-economic, physical, functional and geomorphological.
Based on this approach, the methodology was articulated into three phases:

- classification of urban coastal areas in relation to their physical and functional features;
- definition of a new composite index for measuring the urban resilience of urban coastal areas;
- definition of a set of urban adaptation actions.

Furthermore, such methodology was set up considering the opportunity to implement it using Geographic Information Systems (GIS). From an urban planning perspective, indeed, GIS can effectively support the decision permits to manage, analyze, process and synthetize spatial data in order to support effectively the decision-making process (Huxhold, 1991).

3.1 CLASSIFICATION OF THE URBAN COASTAL AREAS IN URBAN TYPOLOGIES

In general, a classification of urban area typologies represents a key aspect for a better evaluation of the urban transformations that should be implemented (Gargiulo, 2014).
Usually, scientific studies on this topic distinguish coastal areas in relation to the land use (e.g. McGranahan et al., 2005), while a classification based on functional and physical features of coastal areas is mainly considered in terms of the basic urban/rural dichotomy. However, this classification is not useful for understanding which interventions are possible to implement at the local level in order to increase their resilience.
Hence, both in relation to the literature review and the analysis of the urban adaptation plans, a new classification was defined. The classes of urban coastal areas refer both to their physical and functional characteristics. In particular, the Urban Coastal Units represent classes of urban coastal areas that are homogenous in relation to their physical and functional features. In relation to these, coastal cities can be articulated into six urban coastal typologies that are:

- *Compact Urban Areas:* urban areas characterized by high population density, high dense urban fabric, and a high functional stratification (e.g. historic centers and consolidated urban areas);
- *Monofunctional and Facility Urban Areas:* urban areas characterized by a highly specialized function and a specific physical configuration (e.g. industrial and commercial areas, airports, station);
- *Residential Areas:* residential areas characterized by medium and low population density (e.g. sub-urban areas);
- *Tourist Facility Areas:* urban areas characterized by a variable population density and by the presence of several accommodation facilities and activities related to tourism;
- *Potential Redevelopment Areas:* urban areas abandoned that can potentially be planned for redevelopment (e.g. brownfield sites);
- *Natural Coastal Areas:* coastal areas not urbanized and characterized by the presence of coastal ecosystems (e.g. wetlands).

In order to articulate an urban coastal area in these categories, a set of five indicators was defined. These indicators refer to the land use and the land-use intensity of a coastal area. In relation to the land use, the Urban Atlas classification was taken into account. In particular, the 20 Urban Atlas' classes were reduced into four land-use classes.
In relation to the land-use intensity, the indicators are:

- *Population Density:* it is measured as the number of inhabitants per square kilometer;

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- *Job-Housing Ratio* (or *Employment to Housing Ratio*)*:* it is measured as the number of employees and the number of inhabitants in the area;
- *Tourism Employment:* it is measured as the percentage of workers in the tourism industry in relation to the total number of workers in the area;
- *Tourist Capacity:* it is measured as the ratio of the total number of accommodation beds and the total of inhabitants in the area.

In order to articulate coastal cities in these six urban typologies, a benchmark value has to be set for each land-use intensity indicators. After mapping these indicators, through the combination of the five maps, it is possible to obtain a classification of coastal cities according to the six urban coastal typologies as described above.

3.2 DEVELOPMENT OF A NEW INDEX FOR MEASURING THE URBAN COASTAL RESILIENCE

The literature review highlighted that there is a widespread use of coastal vulnerability indices. From an urban planning perspective, these indices do not take into account how the urban layout of coastal areas and their functional organization may affect their coastal vulnerability. Furthermore, these indices are based on the critical aspects of these areas and do not take into account those characteristics of the coastal urban system that may improve its response capacity during a coastal flooding event. Therefore, a new composite index was developed. Such index measures the "urban coastal resilience" that is the capacity of an urban coastal system to reach and maintain an acceptable level of functioning and structure during a coastal flooding. In this perspective, this index can be used in urban planning for a better definition of the prevention and preparation stages (Etinay et al., 2018, van Dongeren et al., 2018) in order to reduce the impacts of coastal flooding on urban areas.
Considering the literature review and the adaptation strategies' analysis, twelve characteristics and their relative variables were identified. According to the systemic approach described above, those characteristics were articulated into four categories (Tab. 3).

CATEGORY	CHARACTERISTIC	CATEGORY	CHARACTERISTIC
Socio-economic	Education	Functional	Transport network
	Age		Ground floor uses
	Employment		Public facilities
Physical	Imperviousness degree	Geo-morphological	Slope
	Building typology		Water body
	Conservation of buildings		Distance from coastline

Tab. 3 Index's characteristics

Concerning the weighting method for developing the index, a multi-attribute decision-making methods developed by Thomas Saaty (1987) was used, namely the Analytic Hierarchy Process (AHP) . About the choice of the aggregation method, the new index was developed as a linear aggregation of variables calculating the weights for each variable by means of the AHP technique.
However, in order to use the AHP and considering the lack of information in literature about the relationships among the selected indicators', a Delphi survey was necessary. Indeed, the Delphi study is used when "there is incomplete knowledge about a problem or phenomenon". The Delphi study was carried out on an

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international panel of 135 experts, composed of academics and researchers of the topic, professionals and technical experts working in public administration with experience on the issue of coastal flooding. After collecting the experts' opinions, thanks to the AHP, it was possible to calculate the weights of each characteristic. In particular, to date, the opinions expressed by the experts highlight that the main importance is played by the geo-morphological characteristics (about 34%), while socio-economic ones have less influence on the urban resilience of a coastal area (18%).

Finally, the index measures four urban coastal resilience's levels, articulated as *high*, *medium-high*, *medium-low* and *low*.

3.3 DEFINITION OF THE URBAN ADAPTATION CLASSES

Adaptation of urban coastal areas represents a need for coastal communities in order to reduce their vulnerability to coastal flooding impacts and, at the same time, it can be an opportunity for increasing the quality of life in those areas. The possible adaptation approaches for coastal communities are mainly three (Nicholls et al., 2007):

- *Accommodation:* it considers modifications to the urban layout and organization in relation to the flooding exposure;
- *Protection:* it includes the placement of natural (soft measures) or infrastructural (hard measures) barriers in an exposed area in order to reduce the impacts of flooding events;
- *Retreat:* it concerns the delocalization of activities and communities from high-risk areas to low-risk areas.

Although the differences among these three approaches, it is possible to articulate urban transformations referred to them according to systemic approach. Therefore, urban adaptation actions can be expressed by the concepts of (i) land use, (ii) land-use intensity, and (iii) urban form.

Land use expresses the relationships between the urban activities localized in an area and the adapted urban space (Gargiulo, 2009). Land-use intensity indicates the amount and degree of urbanization of an area (Wellmann et al., 2018) in relation to its main urban function. Urban form refers to the urban physical characteristics that include housing type, street type, etc.

In relation to these three urban factors, four classes of urban adaptation actions were defined:

- Maintain the land use (1);
- Reduce the land-use intensity and maintain the urban form (2);
- Reduce the land-use intensity and change the urban form (3);
- Change the land use (4).

Each of these classes is linked to a specific adaptation approach. In particular, (1) and (2) are referred to the Accommodation approach, while (3) and (4) are respectively referred to the Protection and the Retreat approach. In relation to the resilience levels measured by the index described above, the range of the urban adaptation actions is inversely proportional to the urban coastal resilience level: if the resilience level is *high*, the urban transformations will be poor (e.g. A.1); otherwise, if resilience level is *low*, the urban transformations will be more significant (e.g. R.4).

4 CONCLUSION

This paper illustrates a methodology developed for supporting decision-makers in the definition of effective urban transformations that are able to reduce the impacts due to coastal flooding on urban areas. As

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emerged from the literature review and the analysis of the adaptation plans, the difficulty to define spatial planning tools for supporting decision-makers in the definition of effective urban transformations of urban coastal areas depends from the use of approach based mainly on the vulnerability concept that considers specific urban aspects, in particular social and geo-morphological ones. Instead, the urban coastal adaptation is a complex issue that requires an approach that considers the complexity of urban coastal systems.

In this perspective, the methodology described in this paper was developed adopting a systemic approach. This approach permits not only to consider the complexity of relationships between coastal cities and coastal flooding impacts but also to overcome the current limitations of the scientific debate. In particular, due to the sectorial approach adopted for the coastal vulnerability assessment, there is still a gap between the measurement of the ability of the coastal system to respond to flooding stimuli (resilience) and the definition of effective urban adaptation actions to reduce the impacts of coastal flooding. The use of the systemic approach, instead, provides more guarantees to fill this gap and support better decision-makers in the management of the future urban transformations along the coastline. Furthermore, in relation to these aspects, such methodology was developed considering its application in GIS environments in order to support more effectively the decision-making process.

In this perspective, future developments of this work will concern the GIS implementation and the application of such methodology to a case study. In particular, it will be necessary to define an operative framework for the development of the methodology in the GIS environment. Hence, through the analysis of the case study's application, it will be possible to not only assess the correctness of the methodology but also consider the opportunity to develop a new operative GIS-based tool for supporting more effectively decision-maker process.

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ECOSYSTEM SERVICES FOR SPATIAL PLANNING

A REMOTE-SENSING-BASED MAPPING APPROACH

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ABSTRACT

The role of sustainability is becoming even more important in the framework of urban and spatial planning since human well-being is strictly correlated to environmental health. At the same time, new technologies are spreading and permit to have even more spatial information, also thanks to the open access to several satellite images. The topic of ecosystem services mapping, useful to provide an overview of the relationship between the environmental and the territorial and human dynamics, today is still under discussion since it is highly dependent on the type and availability of data, which is not always homogeneous for all the areas. Satellite data can be considered a solution since, in addition to providing homogeneous, continuous and real-time data, they provide quantitative and spatially explicit information that are currently spatialized for ecosystem services assessments with land use land cover maps. Vegetation indices not only are able to identify the distribution of vegetation, but also act as a proxy for mapping and quantifying different ecosystem services linked to biomass provision. A methodology of ecosystem services mapping and assessments on the basis of satellite data is presented in a case study. Through a multi-temporal series of Landsat 8 satellite images collected for the year 2016, the distribution and the magnitude of the ecosystem services associated to biomass provision are mapped using the SAVI (Soil Adjusted Vegetation Index). Such information is subsequently spatialized in relation to a land use land cover map. Finally, results are discussed on the basis of the spatial distribution of ecosystem services and their relationship with different land uses.

KEYWORDS

Ecosystem Services Mapping; Satellite Images; Soil Adjusted Vegetation Index; Plant Biomass; Land Uses

1 INTRODUCTION

The role of sustainability is becoming even more important in the framework of urban and spatial planning since human well-being is strictly correlated to environmental health. At the same time, new technologies (Information and Communication Technology – ICT) are spreading and permit to have even more spatial information, also thanks to the (relatively new) open access to several satellite images, which provide consistent and continuous series of real-time, spatially homogeneous and free of charge data. Even though Remote Sensing (RS) technologies are not that recent, their use has been spreading only in the last period, also thanks to the increasing number of free of charge satellite data provided by non-commercial satellites (e.g. Modis, Landsat, Sentinel). Data coming from satellite images have the potential to be related with other relevant spatial and non-spatial data in order to obtain different data and information products, using methods and tools regarding image analysis techniques, spatial and geo-statistical analysis within GIS-based frameworks. More relevant data coming from satellite images are Vegetation Indices (VIs). Furthermore, the management and analysis of geospatial data from multi-source databases provide important and complex information that can be used in the monitoring, analysis and assessment of environmental concerns, coping with current global challenges such as Climate Change (CC) and environmental sustainability of our cities and territories, which in turn can be communicated to decision-makers to drive and support the development of appropriate strategies and policies.

In this framework, the application of Ecosystem Services (ES) helps to increase awareness that natural ecosystems provide the basis for human well-being, which is a core advantage of this concept (Koschke et al., 2013). Furthermore, ES will have a challenging role in reducing the vulnerability of society to CC (Vignola et al., 2009). ES are the benefits, like services and goods, people obtain from ecosystems (MA, 2005) and are distinguished in four categories: supporting services (services that are necessary for the production of other ES, e.g. nutrient cycling, primary production, soil formation), provisioning services (products obtained from ecosystems, e.g. food, fuelwood, fresh water), regulating services (benefits obtained from the regulation of ecosystem processes, e.g. climate regulation, water regulation, pest and disease control) and cultural services (nonmaterial benefits people obtain from ecosystems, e.g. aesthetic, spiritual, educational values). Because of the spatial peculiarity of ES, mapping their distributions and changes over time has the potential to aggregate complex information (Burkhard et al., 2012), e.g. for ES trade-offs analysis (Gissi et al., 2014, 2016, 2017). This visualization of ES can be used by decision-makers, e.g. land managers, as a powerful tool for the support of landscape sustainability assessments (Swetnam et al., 2011). As a supporting tool it can assist stakeholders and decision-makers (land managers, local or regional planning authorities) in developing sustainable land use strategies (de Groot et al., 2010; MA, 2005; Koschke et al., 2013; Swetnam et al., 2011; TEEB, 2010) and toward a specific policy goal (Gissi et al., 2015). RS supplies consistent time series and real-time data for monitoring ES (Ayanu et al., 2012), providing more accurate and up-to-date information than land use land cover data. It allows not only the description of landcover spatial patterns but also a direct estimation of functional attributes of the ecosystems (Paruelo et al., 2016; Pettorelli et al., 2005), providing quantitative, spatially explicit, and (in some cases) physically based estimates of a number of the biophysical parameters that are currently spatialized for ES assessments with Land Use Land Cover (LULC) maps (Andrew et al., 2014). In particular, VIs can be used as an indicator of productivity during the vegetation growing season (De Araujo Barbosa et al., 2015), since they are able to define phenological variations and photosynthetic potential of crops, allowing to identify crops' growth cycle and process (Brown & de Beurs, 2008; De Araujo Barbosa et al., 2015; Muukkonen & Heiskanen, 2005;

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Prabakaran et al., 2013; Wall et al., 2008; Wardlow & Egbert, 2008). Thus, VIs not only are able to identify the spatial distribution of vegetation, but act as a proxy for mapping and quantitatively assessing the plant biomass provided by ecosystems (De Araujo Barbosa et al., 2015) and several ES linked with its provision. As reported in literature, these services – and the related biophysical processes generating them – are: climate regulation, through the process of carbon sequestration and storage by vegetation (Atzberger, 2013; De Araujo Barbosa et al., 2015; Egoh et al., 2007; Feng et al., 2010; Pettorelli et al., 2014; Rembold et al., 2013; Zurlini et al., 2014;); soil erosion regulation, occurring thanks to the vegetation cover of soil (Andrew et al., 2014; Ayanu et al., 2012; De Araujo Barbosa et al., 2015; Kandziora et al., 2013), which helps to reduce the water and wind erosion; natural hazard regulation, through the process of mass stabilisation fostered by the vegetation cover of soil (De Araujo Barbosa et al., 2015); water cycling and regulation, through the structural and functional properties of vegetation (Zurlini et al., 2014), which feed this cycle, filtering and purifying the water; maintenance of soil fertility, through the structural and functional properties of vegetation (Ayanu et al., 2012; Zurlini et al., 2014), which establish a mutual relationship with the soil, feeding the nutrient cycle; net primary productivity, through the process of capture of the solar energy from the chlorophyll (Zurlini et al., 2014).

A methodology of ES mapping and assessment on the basis of satellite data is presented in a case study, by analysing the distribution and the magnitude of ES linked to the provision of biomass, mapped using a VI as a proxy, in relation to a LULC map. Results are discussed on the basis of the spatial distribution of ES and their relationship with the different land uses and territorial dynamics.

2 METHODOLOGY OF ECOSYSTEM SERVICES MAPPING USING SATELLITE DATA: A CASE STUDY

The case study area corresponds to the Province of Rovigo (Veneto Region, Northern Italy). A multi-temporal series of eight satellite images (Landsat 8) at 30m spatial resolution have been collected for the year 2016, so as to cover all the seasons and, consequently, all the stages of the vegetation growing cycle. The use of the multi-temporal series of satellite images, not only provide a more accurate classification (Prishchepov et al., 2012), but also allows to map the seasonal vegetation (located especially in agricultural crops) that otherwise, using a single image, is unlikely to be identified if the date of acquisition does not cover the vegetation/crop growing season. For each one of the eight images, the VI called Soil Adjusted Vegetation Index (SAVI) was obtained through the calculation of the ratio between two spectral bands (red band and NIR – near-infrared – band) [1]. Then, the annual average value of the SAVI was calculated from the eight images. From the SAVI annual average value image, wherein to higher SAVI values it corresponds a greater presence of plant biomass throughout the year, it was possible to obtain the spatial and quantitative distribution of ES linked to biomass provision, mapped using the VI as a proxy.

Subsequently, in order to understand the relationship between these ES and the territorial and human dynamics, the SAVI annual average value image has been associated with the regional LULC map of Veneto Region (level III of the Corine Land Cover classification). The method is based on the overlapping of the SAVI annual average value image on the LULC map, computing a geo-statistical calculation which combines to each object of the LULC map the corresponding SAVI average value of all the pixels located within the

[1] Formula of the SAVI: (1 + L) * (NIR band – RED band) / (NIR band + RED band + L), where L is the correction factor for the soil brightness, defined as 0.5 to accommodate most land cover types.

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perimeter of the object itself [2]. In this way, it is possible to know the capacity of the territory and different land uses to provide ES linked to biomass provision.

3 RESULTS

Fig. 1 shows the map related to the spatial distribution of the SAVI annual average value within the territory of the province of Rovigo, obtained from the eight satellite images of the time series.

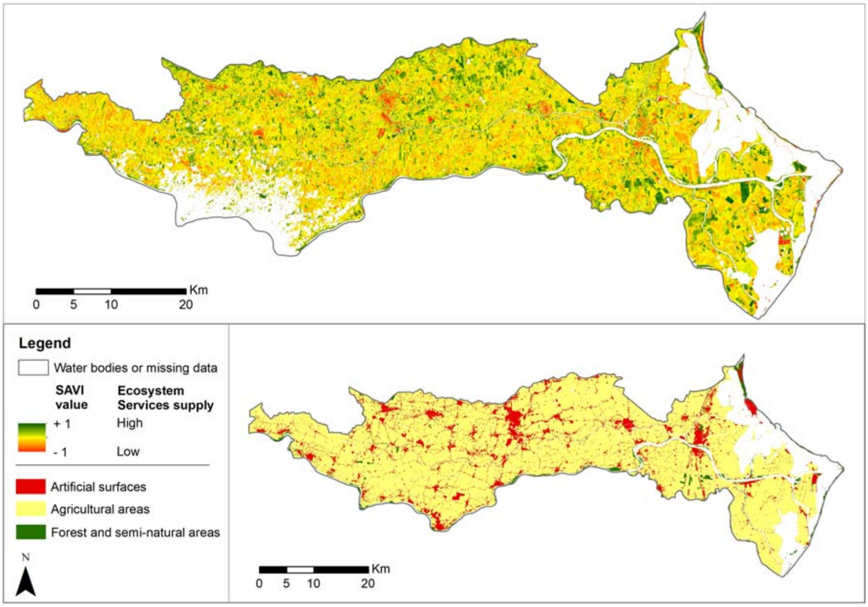

Fig. 1 Map of the SAVI annual average value for the year 2016 (up) and map of the regional LULC – only terrestrial ecosystems – (down)

Associating the map of the SAVI annual average value with the LULC map shown in Fig. 1, by applying the method previously described, three maps related to the capacity of the territory (and of each object and LULC class) of the province of Rovigo to provide ES linked to biomass provision has been elaborated, according to the different terrestrial ecosystems: artificial surfaces (Fig. 2), agricultural areas (Fig. 3) and forest and semi-natural areas (Fig. 4). In addition, for each one of the three maps, the SAVI average value of the objects located within each LULC class was calculated (Tables 1, 2, 3).

The LULC classes related to the artificial surfaces having the higher SAVI values, besides the class "airports" (it's about an herbaceous airfield), are the ones related to the "green urban areas" and "sport and leisure facilities", followed by "soil with special uses (under transformation)" and "widespread urban fabric". The classes having lower SAVI values are the ones related to the "continuous urban fabric", "port areas" and "Industrial or commercial units".

[2] The analysis has been carried out on the terrestrial ecosystems, corresponding to the LULC classes related to 1. Artificial surfaces, 2. Agricultural areas and 3. Forest and semi-natural areas.

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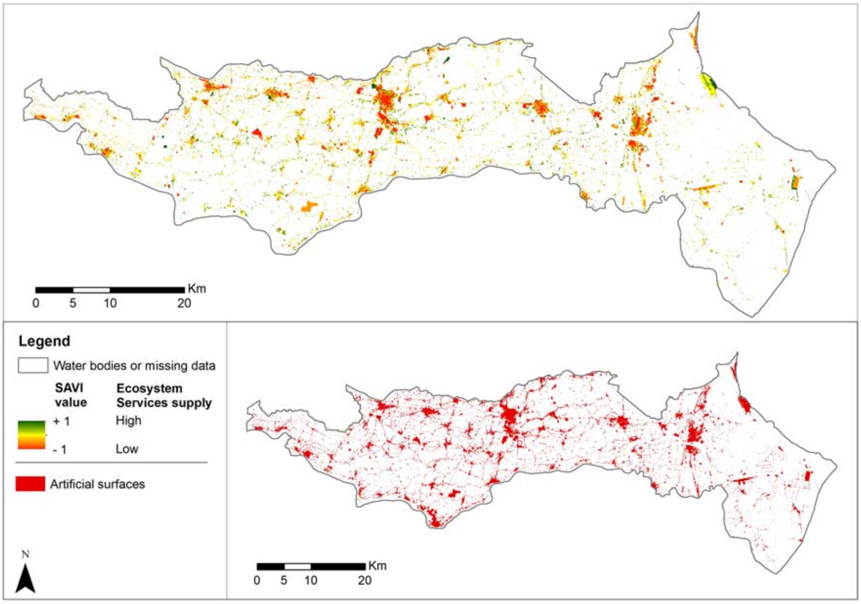

Fig. 2 Map of the capacity of the territory, related to the artificial surfaces, to provide ES linked to biomass provision

LULC CLASSES (ARTIFICIAL SURFACES)	SAVI VALUE	AREA (HA)
1.1.1. Continuous urban fabric	0.14	77
1.1.2. Discontinuous urban fabric	0.29	6,417
1.1.3. Widespread urban fabric	0.32	2,956
1.2.1. Industrial or commercial units	0.24	3,554
1.2.2. Road and rail networks and associated land	0.28	2,274
1.2.3. Port areas	0.14	55
1.2.4. Airports	0.45	8
1.3.1. Mineral extraction sites	0.29	69
1.3.2. Dump sites	0.28	41
1.3.3. Construction sites	0.29	271
1.3.4. Soil with special uses (under transformation)	0.33	269
1.4.1. Green urban areas	0.34	723
1.4.2. Sport and leisure facilities	0.35	725
1. ARTIFICIAL SURFACES	0.30	17,439

Tab. 1 SAVI average value of the objects within LULC classes related to the artificial surfaces

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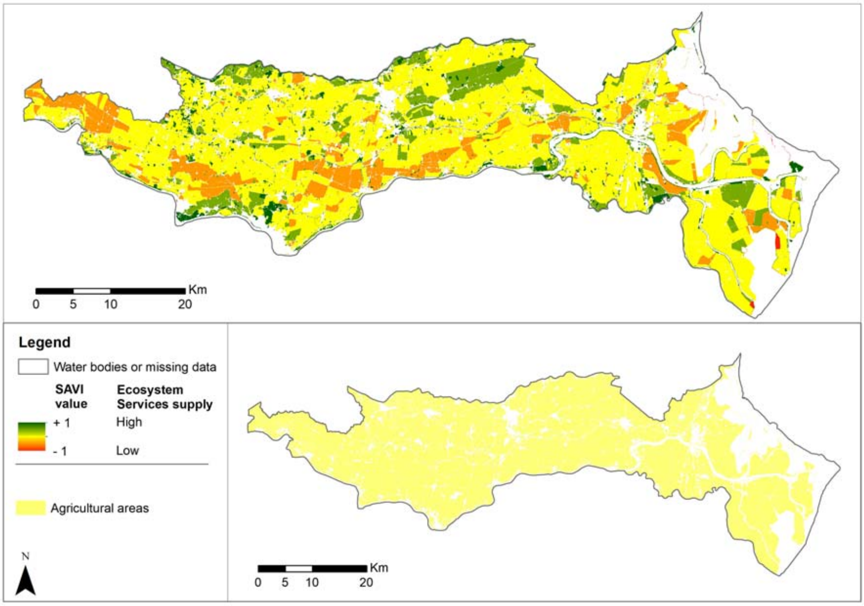

Fig. 3 Map of the capacity of the territory, related to the agricultural areas, to provide ES linked to biomass provision

LULC CLASSES (AGRICULTURAL AREAS)	SAVI VALUE	AREA (HA)
2.1.1. Non-irrigated arable land	0.34	1,363
2.1.2. Permanently irrigated land	0.32	124,959
2.2.1. Vineyards	0.37	548
2.2.2. Fruit trees and berry plantations	0.38	2,202
2.2.4. Other permanent crops	0.38	1,274
2.3.1. Pastures	0.36	2,350
2.3.2. Permanent grassland	0.33	2,584
2.4.1. Annual crops associated with permanent crops	0.33	6
2.4.2. Complex cultivation patterns	0.36	500
2. AGRICULTURAL AREAS	0.35	135,786

Tab. 2 SAVI average value of the objects within LULC classes related to the agricultural areas

All the LULC classes related to the agricultural areas have similar SAVI values. The ones related to the "fruit trees and berry plantations" and "other permanent crops" have slightly above SAVI values, while the class related to the "permanently irrigated land" has a slightly below SAVI value.

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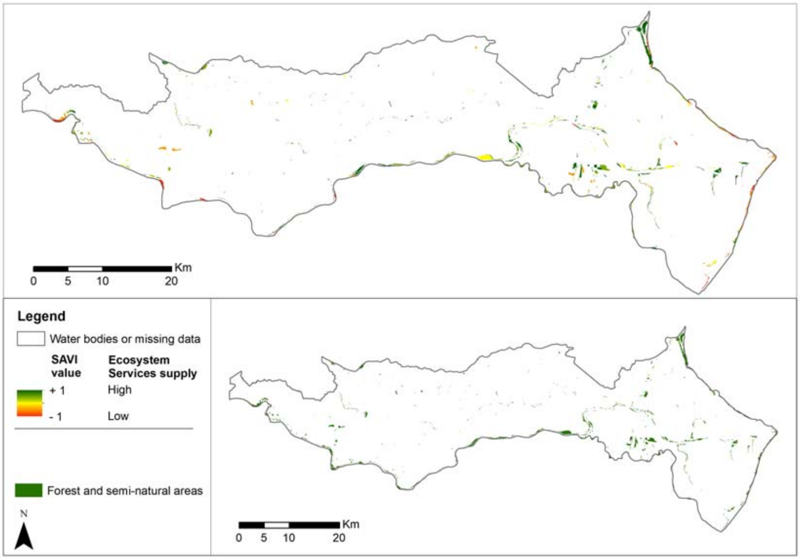

Fig. 4 Map of the capacity of the territory, related to the forest and semi-natural areas, to provide ES linked to biomass provision

LULC CLASSES (FOREST AND SEMI-NATURAL AREAS)	SAVI VALUE	AREA (ha)
3.1.1. Broad-leaved forest	0.37	2,210
3.1.2. Coniferous forest	0.41	233
3.2.1. Natural grasslands	0.27	2
3.2.2. Moors and heathland	0.37	95
3.2.3. Sclerophyllous vegetation	0.41	39
3.3.1. Beaches, dunes, sands	0.14	712
3.3.2. Bare rocks	0.17	4
3. FOREST AND SEMI-NATURAL AREAS	0.34	3,295

Tab. 3 SAVI average value of the objects within LULC classes related to the forest and semi-natural areas

The LULC classes related to the forest and semi-natural areas having the higher SAVI values are the ones related to the "coniferous forest" and "sclerophyllous vegetation", followed by "broad-leaved forest" and "moors and heathland". The classes having lower SAVI values are the ones related to the "Beaches, dunes, sands" and "bare rocks".

4 DISCUSSION

The analysis of the capacity to provide ES linked to biomass provision of each LULC class allows to identify the role of the different land uses, which lie behind the territorial and human dynamics, in supplying such

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ES, in coping with the sustainability and resilience of our society and territories. In the case study area of the province of Rovigo, the SAVI mean value of all the objects related to the terrestrial ecosystems is 0.32. In general, the artificial surfaces, as expected, show a lower SAVI mean value (0.30), demonstrating a lower capacity to provide ES linked to biomass provision than the agricultural areas and the forest and semi-natural areas, which show similar SAVI mean values (respectively 0.35 and 0.34). Analysing single LULC classes, it results that the "coniferous forest" and the "sclerophyllous vegetation" (both related to forest and semi-natural areas) are the ones with the highest capacity to provide such ES, followed by the classes related to the "fruit trees and berry plantations", "other permanent crops" and "vineyards" (related to agricultural areas), and "broad-leaved forest" and "moors and heathland" (related to forest and semi-natural areas). All these classes are marked by a common factor: they are all characterized by trees, shrubs or woody crops, emphasizing the importance of providing ES of such vegetation types. The area covered by these classes (6,601 ha) is only the 4% of the whole case study area (156,520 ha). Other classes with a higher than normal (SAVI value > 0.32) capacity to provide ES linked to biomass provision are the ones related to the other types of cultivation in agricultural areas (except "permanently irrigated land") and the artificial surfaces related to "sport and leisure facilities", "green urban areas" and "soil with special uses (under transformation)". "Permanently irrigated land" is the most common LULC class within agricultural areas (92% of the whole agricultural surface), while simultaneously is the LULC class within agricultural areas with the lower capacity to provide ES linked to biomass provision. Concerning the artificial surfaces, of great importance for the provision of ES are the areas for sport and leisure activities and the urban green spaces (1,448 ha), covering the 8% of the whole artificial surfaces (17,439). Most of the artificial surfaces (87%) are covered by classes related to "discontinuous urban fabric" (6,417 ha), "widespread urban fabric" (2,956 ha), "industrial or commercial units" (3,554 ha) and "road and rail networks and associated land" (2,274). All these classes have a lower than normal (SAVI value < 0.32) capacity to provide ES linked to biomass provision, except "widespread urban fabric". It is worthwhile underlining that this latter class has the highest capacity to provide ES between all the classes related to urban fabric, even though the urban sprawl is considered to produce environmental degradation (Johnson, 2001). It is also true that, if "widespread urban fabric" class covered less areas, it could be room for LULC classes with higher capacity to provide ES (e.g. forests).

5 CONCLUSION

This study presents a methodology of ES mapping using a multi-temporal series of satellite data and a LULC map, suggesting an innovative spatial approach for the analysis of the relationship between the territorial and human dynamics and the provision of ES, which could support a better and more sustainable management of the territory. Such methodology can be easily replicated in other case studies because of the intrinsic characteristics of (non-commercial) satellite data: large spatial coverage, timely availability, temporal continuity and free access. The case study of the province of Rovigo shows, once again, the important role in providing ES played by forests and vegetated semi-natural areas, as well as by the urban green spaces and recreational areas within the urban settlements. However, they cover only a small part of the case study area. Moreover, it shows that most of the agricultural lands is cultivated with crop types and cultivation techniques that do not allow a high provision of ES. This analysis wants to stimulate further remarks and insights about the relationship between the provision of ES and the territorial and human dynamics, in order to support a better planning and management of the territory for the enhancement of the environmental sustainability and human well-being.

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INTEGRATING PARTICIPATORY MODELLING IN RISK MANAGEMENT

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ABSTRACT

Participatory modelling (PM) techniques aim at involving stakeholders and local communities' knowledge to support risks assessment management in social-ecological systems (SES). Understand SES complexity means consider unique socio-economic and cultural values, direct and indirect experiences, political characteristics that have influenced the formation of a community's risk understanding and local knowledge. Comprehending the complexity of these interactions could help to exchange information and knowledge, leading to a better comprehension of the problem formulation through social learning processes and to facilitate conflict resolution. Evidences demonstrated that there is the need to require not only a deep understanding of the main physical phenomena to be addressed, but also a knowledge about stakeholders' type, level of cooperation between different stakeholders and their risk perception. Once the problem is well understood, and stakeholders included in the process, it is possible to find more efficient adaptive management solutions to enhance the resilience of the system. For this reason, to improve risk management processes, it should be considered physical risk and social response in an integrated way. Starting from a literature review, the aim of this work is to demonstrate the role of PM techniques in adaptive risk management to collect knowledge and improve SES management. Specifically, coastal systems (CS) have been analysed. CS are particularly vulnerable to climate change negative impacts. In this sense, it is important to understand that vulnerability is socially constructed and not only determined by the occurrence of a physical event.

KEYWORDS

Participatory Modelling; Social-ecological Systems; Decision Support Systems; Coastal Systems; Adaptive Management

1 INTRODUCTION

A SES perspective helps to place regime shifts within an integrated human-environment context in which social outcomes are contingent upon ecological processes and vice versa (Nayak, 2014). Berkes and Folke (1998) define SES as complex system. Understand SES complexity means consider unique socio-economic and cultural values, direct and indirect experiences, political characteristics that have influenced the formation of a community's risk understanding (Renn & Rohnmann, 2000) and local knowledge refers to the actor's information about environment in which they live (Robertson & McGee, 2003). To collect these information, PM techniques represent a tool for involving stakeholders and local communities' knowledge to support risk assessment management in SES.

Specifically, "participation to support the decision" to manage the complexity in coastal zones would help to address the most efficient solutions to make the most of the natural resources available in a broad and flexible manner (Elliff & Kikuchi, 2015).

In this paper, through a literature review, CS as SES will be analyzed, to understand the role of PM techniques in adaptive risk management. CS are particularly vulnerable because of resources overexploitation of and the overdevelopment in terms of urbanization and infrastructures. Furthermore, they are also vulnerable because of climate change negative impacts (Marengo et al., 2017; Masselink & Gehrels, 2014; Usaid, 2009).

For these reasons, it is necessary to better understand the complexity of the linkages between CS evolution and human society, improving a historically-informed understanding of the interconnections between cities and their environments and particularly between cities and the sea (Mosley, 2014).

2 THE ROLE OF PARTECIPATORY MODELLING IN ECOSYSTEM BASED MANAGEMENT

In the last years, several scientific approaches on natural risk management have conceived SES as complex and adaptive systems (Pollnac et al., 2010). The most notable example to deal with complexity in SES is Ecosystem Based Management (EBM) (Giebels et al., 2016). EBM has been advocated at international level as the best strategy to cope with climate change, lands and oceans protection and to manage human activities in a sustainable way (Arkema et al., 2017; Bigagli, 2016). For instance, several European case studies on the application of an EBM approach to improve ecosystem services are available in scientific literature (Bigagli, 2016; Giebels et al., 2016; Long et al., 2015)

EBM stresses the need to perceive SES as complex systems formed by human and environmental elements (Giebels et al., 2016).

Berkes and Folke (1998) define SES as complex, integrated systems in which there are a mutual feedback between ecological and social subsystems (Nayak & Armitage, 2018). SES are characterized by uncertainty of information, non-linearity of process and self-organization that results (Levin, 1999), and unpredictable effects also across scales (Giebels et al., 2016).

SES complexity is due as different fields, actors and policy levels are involved (Bache & Flinders, 2004; Paavola et al., 2009; Pierre & Peters, 2000). Since policy levels and actors are multiple in such settings, (Bache and Flinders, 2004) complexity management might be necessary (Cash et al., 2006). This seems true for complex issues related to environment, where decision-making processes are amplified or attenuated by public hierarchies to multisectoral, transversal, and holistic collaborative arrangements (Ricart Casadevall,

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2016). Long et al. (2015) listed the key information to develop an EBM strategy as assessment of nature of ecosystem considering spatial and temporal scales, inclusion of adaptive and integrated management, use of scientific knowledge, stakeholders involvement to collect information and knowledge about human-environmental network. Literature shows the existence of different types of participation including a diverse range of activities: from passive participation, in which the objective is just to inform people, to co-management, in which the participants perform the syntheses and include them in a joint decision making process (Voinov and Brown Gaddis, 2008). This paper focuses on "participation to support the decisions". Several examples show the importance of stakeholders' involvement in order to increase the effectiveness of decision support system (DSS) (Sandink, et al., 2016).

2.1 PARTICIPATION TO SUPPORT THE DECISIONS IN ORDER TO MANAGE THE COMPLEXITY OF SES

Using 'participation to support the decisions' to collect knowledge and manage the complexity of SES offers three main benefits. According to Maskrey et al, 2016: (i) normative benefits, that enhance citizen empowerment, equity and social justice in decision making process (e.g. Renn et al., 1998); (ii) instrumental benefits, that enhance the legitimacy of evidence and decisions, and the trust that is afforded to them (e.g. Gaddis et al., 2010; Voinov & Bosquet, 2010) and (iii) substantive benefits, that enhance the quality of the decisions (e.g. Stirling, 2006). Despite these advantages are recognized in many case studies, often stakeholders are not involved in the decision process (Sandink et al., 2016). This depends on community policies, engagement strategies, lack of funding (McIntosh et al., 2011; Quinn, 2010). One of the most common causes of DSS failure is the limited problem understanding due to a failure to structure or a lack of information (Quinn, 2010). According to Tsoukiàs (2008), for a given representation of the problem situation the analyst proposes to the stakeholders a "problem formulation". An understanding of the problem situation is considered a starting point in the stakeholder engagement and DSS development process. There is not optimal mode to stakeholders' involvement in the development of DSS but the choice is based on the socio-environmental context (Sandink et al., 2016). However, many authors have articulated general principles and practices in order to improve the effectiveness of the DSS process (E.g. McIntosh et al., 2011; Voinov & Bousquet, 2010). Some examples have been highlighted as an initial discussion between stakeholders, before the process begins, in order to correctly structure the problem situation (McIntosh et al., 2011); the inclusion of experts and non- experts knowledge (Oliver et al., 2012). A knowledge gap still exists about which type of factors we need and in which type of context (Runhaar, 2009). Understanding the interactions among different decision-makers is a relevant step for mitigating the conflicting interpretation of information due to differences in knowledge, values and beliefs (Giordano et al., 2017; Wolbers & Boersma, 2013) and to increase stakeholders' awareness about a problem situation to improve DSS process. To this aims, taking PM in EBM, and specifically use the 'participation to support the decision' to manage the complexity in coastal zones, would be to address the most efficient solutions to make the most of the natural resources available in a broad and flexible manner (Elliff & Kikuchi, 2015). Understanding the relationships among CS and people reflects an important and international sustainability challenge (Armitage, 2007).

3 THE CASE OF COASTAL SYSTEMS

CS are naturally dynamic systems, subjected to modifications of forms and processes at different time and space scales due to geomorphological and oceanographical factors (Mustelin et al., 2010). In particular, they

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constantly change in response to winds, waves and tides (Mustelin et al., 2010). Coastal areas are the preferred sites for urbanization (Masselink & Gehrels, 2014). As a matter of fact, more than half of the worldwide population live within 100 kilometers from the coastline (Leslie et al., 2015) and the population density is larger than the average with future population growth projections that are the highest worldwide (Masselink & Gehrels, 2014).

Many uses are taking place in the coastal zones for the wide range of essential resources and activities, e.g. human occupation, navigation and communication, living marine resources, mineral and energy resources, tourism and recreation, coastal infrastructure development, coastal environmental quality protection and beach and shoreline management (Masselink & Gehrels, 2014).

Some of these uses produced the overexploitation of resources and the worsening of CS resilience (Marengo et al., 2017; Masselink & Gehrels, 2014; Usaid, 2009). In particular, as highlighted by Masselink and Gehrels (2014) the "overdevelopment of the coast in terms of urbanization and infrastructure has significantly increased our vulnerability to coastal erosion and flooding".

Moreover, CS are vulnerable to climate change impacts, in particular by the pressures given by sea level rise (Masselink & Gehrels, 2014; Usaid, 2009). Climate change will continue to impact coastal communities, affecting approximately 2.7 billion people, and ecosystems, increasing the exposition to specific hazards such as flooding, coastal erosion, salt water intrusion and ecosystem loss together with extreme climate events (Adger, 2005; Dolan & Walker, 2017; Usaid, 2009; Marengo et al., 2017; Mosley, 2014; Mustelin et al., 2010; Raadgever et al., 2016; Tobey et al., 2010). These biophysical changes exacerbated by climate change would provoke several socio-economic impacts such as loss of infrastructures and coastal resources with the decline of economic, ecological, cultural and subsistence (Masselink & Gehrels, 2014; Najib et al., 2015).

3.1 MANAGING THE COMPLEXITY OF COASTAL SYSTEMS

In the light of the above, it is necessary to better understand the complexity of the linkages between CS evolution and human society, improving a historically-informed understanding of the interconnections between cities and their environments and particularly between cities and the sea (Mosley, 2014).

According to Usaid (2009), vulnerability assessment for climate change in coastal areas regards three factors "i) the nature and magnitude of climate variability and change; ii) the human, capital, and natural assets that will be exposed to and impacted by climate change; and iii) the current capacity of coastal communities and ecosystems to adapt to and cope with climate impacts" (Usaid, 2009).

In this sense, vulnerability, seen as a sum of actions and processes, should be considered as a socially constructed and not only determined by the occurrence of a physical event (Dolan & Walker, 2017; Mustelin et al., 2010). In CS an increase of adaptive responses will be required to cope with the negative impacts enhanced by global environmental change (Adger, 2005).

As stated by Weinstein et al. (2007) "the successful implementation of sustainable coastal management depends on, and is driven by, societal values." There is the necessity to better understand the human-induced causes and the social drivers of environmental changes and the way human behaviors could coincide with environmental and social priorities (Weinstein et al., 2007).

Literature underlines the necessity to improve science-based and participatory decision-making processes for effective management of CS (Granek et al., 2010) and states EBM as one of the approaches put forward to improve management (Christensen et al., 1996; Granek, 2010; McLeod et al., 2005; Slocombe 1998).

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Just to give some examples, in the Urdaibai Estuary (Basque Country, Northern Spain), as in many other Mediterranean coastal zones, many different interests coexist resulting in difficulties to manage the system in a sustainable way leading to a great challenge. Thanks to a two-year collaborative research process, the improvement of the integration of different expertise and values, through a mutual learning process, led to define relevant policy options and decisions in the face of complexity, value conflict and unavoidable uncertainty (Garmendia et al., 2010). Furthermore, Boström, Dreyer, and Jönsson (2011) focused their research on the challenges for stakeholder participation and risk communication in the Baltic Sea. What emerged from this study was that the inclusion of a broad range of actors has the potential to facilitate environmental risk governance.

Risk and vulnerability perceptions of stakeholders and local communities play a crucial role in building inclusive and responsive decision-making adaptation processes (Bonatti et al., 2016; Slovic, 1987). Moreover, the investigation of public perceptions is necessary for the comprehension of adaptation and transforming vulnerability states (Bonatti et al., 2016; García de Jalón et al., 2013). Community level perceptions nowadays and historical memory could also help to investigate the peculiarities that enable and/or constrain communities to respond, recover and adapt (Mosley, 2014). In this sense, it seems clear that scientific views of changes could be more efficacious with the inclusion of local knowledge systems (Marengo et al., 2017; Mosley, 2014).

Coastal communities need to enhance their knowledge of local climate change consequences and to explore preferences for adaptation options, to build resilience of CS (Marengo et al., 2017).

For this reason, there is the necessity and urgency to include coastal communities' participation in coastal adaptation strategies as part of effective coastal management (Usaid, 2009).

As a matter of fact, it seems clear that risk adaptive management strategies should be considered more and more as a governance issue because they are not only a technical matter (Raadgever et al., 2016). It is important to work in the direction of proactive adaptation strategies because they "aim to address the full range of coastal climate change hazards in ways that meet social objectives" (Tobey et al., 2010).

4 CONCLUSION

Starting from a literature review, the paper has tried to demonstrate the role of PM techniques in adaptive risk management to collect knowledge and improve SES management.

As a matter of fact, it has been highlighted that expert knowledge is insufficient to deeply understand a problem situation. Instead, it is recognized that in many decision-making processes the adoption of a participatory paradigm is needed to build a co-production knowledge. PM techniques, and specifically the "participation to support the decision" type, are very important to increase the effectiveness of DSS of problematic situations and, despite an increasing array of successful applications of a PM in EBM approach towards climate change impacts in coastal environments, planning and implementing adaptation strategies is still under development.

Furthermore, the analysis of the case of CS allows to highlight the necessity to improve science-based and participatory decision-making processes for effective adaptive management.

In this step, the analysis of general risks on CS has been taken into consideration. Moreover, the research will continue through a more deeply analysis of one of the main risks due to the increase of the exposition to specific hazards related to CS.

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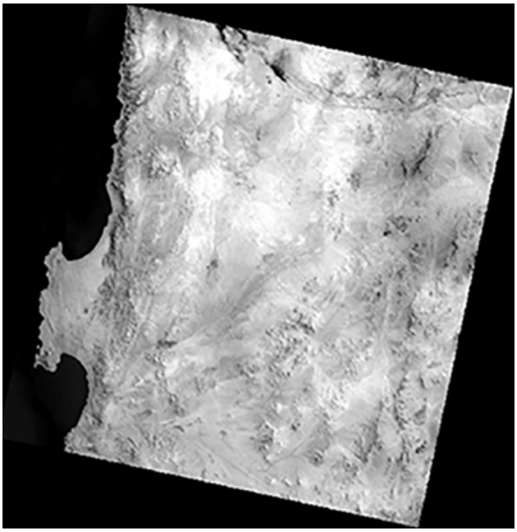
Stefania Santoro. Environmental Engineer. Research Fellow for Water Research Institute of National Research Council (Italy), Bari. My research activity aiming at underling the importance of knowledge management and perception elicitation as important step for the design and implementation of disaster management policies. The aim is analys the elements influencing risk perceptions, such as socio - economic dynamics, interaction networks, previous experiences, values, cultural factors and knowledge of people involved in a problematic situation, starting from participatory modelling approaches in order to collect information, compare differences between individuals and/or groups of stakeholders involved, and to improve the decision support process to reduce natural risk.



SURFACE TEMPERATURE VARIATION AND URBAN HEAT ISLAND INTENSITY IN ANTOFAGASTA, CHILE

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ABSTRACT

Landsat 8 satellite images will be collected to determine how urban heat islands have changed in Antofagasta during the period between June 2013 and March 2018. In this way its possible to determine whether or not there has been an increase in Surface temperaturas in the city and in different sectors that can mean heat sources within the city. The results obtained will be compared with records of atmospheric temperatures, where the values will be collected by datta loggers, which are under the FONDECYT 1100657 project, which seeks to assess how climate change is affecting different urban centers in the country. With each one of these antecedents, it will be possible to verify the evolution that has manifested the temperature itself during the last 5 years, with the possibility of projecting the results to a future and to verify if the city can be affected by climate change.

KEYWORDS

Urban Heat Islands; Climate Change Surface Temperatura; Landsat Images

1 INTRODUCTION

The phenomenon of urban heat island (UHI) is that cities tend to be, especially at night, warmer than the rural environment or less urbanized that surrounds them (Oke, 1973, 1976). Singularly, the urban area that presents higher temperatures often coincide in the center of the cities, where the constructions and buildings form a dense and compact set. The main causes that contribute to the generation of heat islands are (Romero & Sarricolea, 2006; Romero & Molina, 2008): Thermal and calorific properties of building materials; anthropogenic heat production from the different activities and combustion processes, and increased absorption of solar radiation, due to the capture effect produced by the unique geometry of streets and buildings. In the last years, UHI intensity of South American cities has increased in 1-2 ºC per decade (Carrasco et al., 2017; Inostroza, 2014), placing the phenomenon among the most visible effects of climate change. To assess correctly the UHI intensity is the first step in defining adaptation and mitigation strategies (Monge-Barrio & Sanchez, 2018; Pinto, 2014; Sosa et al., 2017). Antofagasta is a city that is located in the north of Chile within the climate that is known as coastal desert, characterized by its aridity. Largely determined by the influence of the Pacific Anticyclone. The temperatures are moderate (they border the 18°C) and have low thermal amplitude both daily and annually. In addition, rainfall is scarce. However, there is no record of how the heat islands have varied within the city, unlike other cities in Chile, such as Santiago or Valparaíso. Therefore, in the next investigation, Landsat 8 satellite images will be collected within the area where Antofagasta is located. Then, they will be entered into the ArcGis software, which is a program that allows studying different environmental, geological, geographical variables, etc. In this opportunity, it will be used to calculate the surface temperature that has existed in Antofagasta during the last 5 years and in this way, verify how the climate change has manifested in the city (Nichol, 1996; Stathopulou & Cartalis, 2007).

2 METHODOLOGY

2.1 SELECTION OF SATELLITE IMAGES LANDSAT

Will look for photographs that are available within the UTM 19 H projection (area where Antofagasta is located), and then determine which will be used for the investigation. The requirements that must be taken into consideration to accept an image and be able to carry out research studies are: No clouds can be perceived that hinder the visual of the city and, in addition, it must be close to the solstices and equinoxes of every year. It must be taken into consideration, that the Landsat image covers a large area of what corresponds to the region of Antofagasta, so a polygon must be created that encloses only the area of the city, which is done once satellite photography is incorporated into the ArcGis software. Then, tables are presented that show the dates that were chosen for the analysis of the research, in addition to the time they were captured and the percentages of perceptible clouds within the Landsat image.

2.2 CALCULATION OF THE SURFACE TEMPERATURE

For this analysis, the SW algorithm will be used. This equation is based on the fact that the radiation absorbed by the atmosphere is proportional to the difference in brightness between the simultaneous measurements at two different wavelengths, corresponding to the two bands of the TIRS sensor. From the data measured by the sensor, the reflected energy can be obtained, since the spectral irradiance measured is a consequence of

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the reflection of the electromagnetic radiation in the covers. This reflection is coded with a numerical value, which is called DN (Digital number), according to the specific calibration coefficients for each sensor.

AUTUMN EQUINOX			WINTER SOLSTICE		
DATE	CLOUDS (%)	HOUR	DATE	CLOUDS (%)	HOUR
21-03-2014	0.11	10:39	06-06-2013	7.23	9:43
08-03-2015	0.08	10:38	09-06-2014	6.20	9:41
26-03-2016	0.08	10:39	12-06-2015	9.08	9:40
29-03-2017	2.06	10:39	14-06-2016	0.20	9:41
16-03-2018	0.19	10:38	17-06-2017	1.52	9:40

Tab. 1 Time of the dates chosen for the calculation of the surface temperature in the period of the autumn equinox and winter solstice

SPRING EQUINOX			SUMMER SOLSTICE		
DATE	CLOUDS (%)	HOUR	DATE	CLOUDS (%)	HOUR
10-09-2013	0.19	10:42	31-12-2013	4.50	11:33
29-09-2014	3.15	10:38	18-12-2014	13.72	11:30
02-10-2015	9.88	10:38	06-01-2016	0.04	11:33
18-09-2016	9.17	10:39	23-12-2016	0.13	11:41
20-08-2017	4.01	10:40	28-01-2018	0.21	11:34

Tab. 2 Time of the dates chosen for the calculation of the Surface temperatura in the periodo f the spring equinox and summer solstice

Given that these coefficients are known, the inverse process can be performed, thus obtaining the values of spectral irradiance detected by the sensor from the DN. To apply the formula of the SW algorithm, it is essential to know these irradiance values. The OLI and TIRS sensor bands can be converted to spectral irradiance values as follows:

$$L_\lambda = M_L * Q_{Cal} + A_L$$

L_λ: Spectral irradiance at the sensor opening (W/sq.m*µm).
M_L: Multiplicative re-scaling factor of the metadata specific band (RADIANCE_MULT_BAND_x, where x is the band number).
A_L: Additive rescaling factor of the metadata specific band (RADIANCE_ADD_BAND_x, where x is the band number).
Q_{Cal}: Value of the standard product of the quantized and calibrated pixels (DN).
From the irradiance values, using the thermal bands can easily derive the temperature at the height of the sensor. The TIRS bands can be converted to brightness temperature using the constants in the metadata file. In this way:

$$T = \frac{K_2}{Ln * \left(\left(\frac{K_1}{L_\lambda}\right) + 1\right)} - 272{,}15$$

T: Brightness temperature of the atmosphere (°C).
L_λ: Spectral irradiance at the sensor opening (W/sq.m*µm).
K_1: Constant of thermal conversion of the specific band of the metadata (K1_CONSTANT_BAND_x, where x is the band number).

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K_2: Constant of thermal conversion of the specific band of the metadata (K2_CONSTANT_BAND_x, where x is the band number).
The metadata is a file that is downloaded together with the Landsat image. Which provides information related to the photography, such as the angle of solar elevation, irradiance and reflectance of each of the bands, etc.

3 RESULTS

3.1 SURFACE TEMPERATURE

The computer program has the ability to digitize the Landsat image in pixels measuring 30 x 30 meters. Then, the city of Antofagasta is presented with the representation made by the software when analyzing the surface temperatures together with the location of each sectors that were selected to study its evolution. On the other hand, graphs with the results obtained during the different periods.

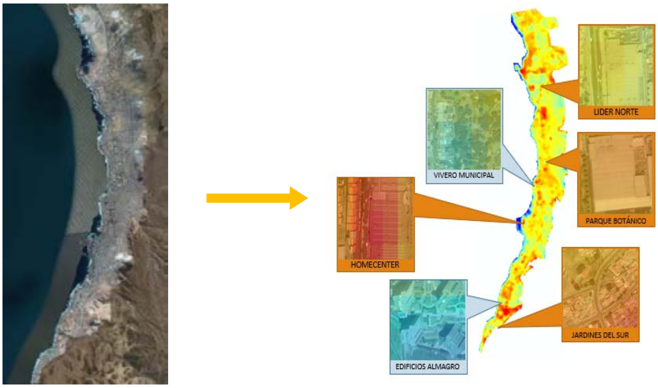

Fig. 1 Interpretation of the surface temperature performed by the software when incorporating the SW equation

By studying each of the graphs, it can be clearly verified that when comparing each of the average temperatures between the sectors and the city of Antofagasta, there is an increasing tendency in most cases, being the Parque botánico with the Lider norte, the areas that present the highest increases within these last 5 years in each of the solstices and equinoxes. Something similar happens in the Jardines del sur, since they also show on average an increasing trend, especially in winter and spring, unlike autumn and summer, where it is characterized by being more balanced. On the other hand, it is interesting the panorama that occurs in the Homecenter, because within each period and each year, it is the sector that in most cases registers the highest heat indexes in the metropolis, but unlike the other zones, does not represent in its totality a tendency in increase when comparing it with the city of Antofagasta. Also, two sectors that represent low temperature levels were taken as an example: Vivero municipal and Edificios Almagro to study the effect of heat island intensity. This concept means that urban spaces increase more in temperature than rural areas.

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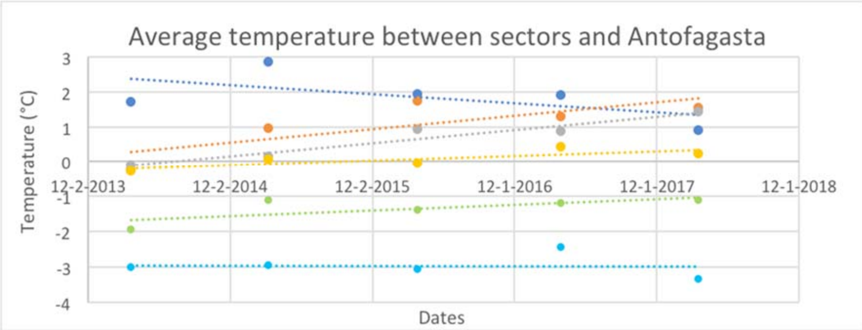

Fig. 2 Trend of the average temperature of each sector with respect to the city of Antofagasta with dates close to the autumn equinox (Blue: Homecenter; Orange: Parque botánico; Gray: Lider norte; Yellow: Jardines del sur; Green: Vivero; Calypso: Almagro)

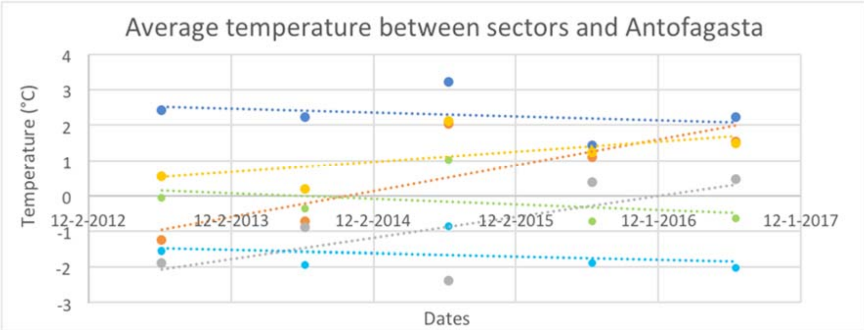

Fig. 3 Trend of the average temperature of each sector with respect to the city of Antofagasta with dates close to the winter solstice (Blue: Homecenter; Orange: Parque botánico; Gray: Lider norte; Yellow: Jardines del sur; Green: Vivero; Calypso: Almagro)

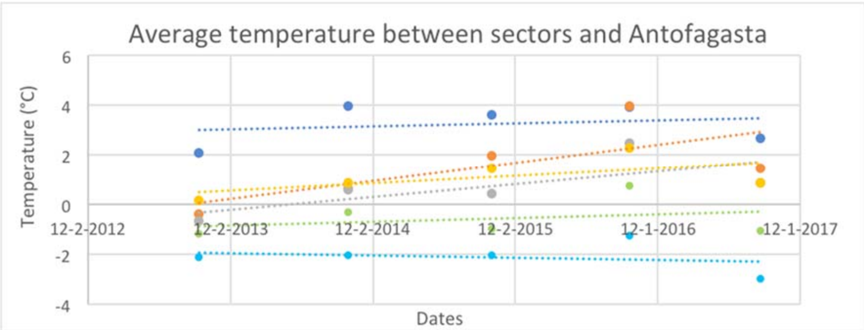

Fig. 4 Trend of the average temperature of each sector with respect to the city of Antofagasta with dates close to the spring equinox (Blue: Homecenter; Orange: Parque botánico; Gray: Lider norte; Yellow: Jardines del sur; Green: Vivero; Calypso: Almagro)

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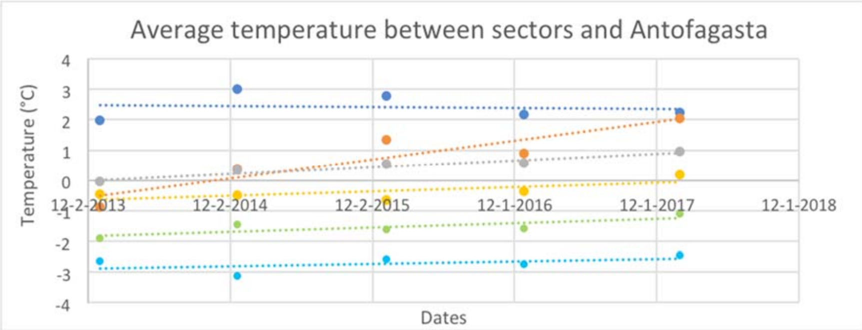

Fig. 5 Trend of the average temperature of each sector with respect to the city of Antofagasta with dates close to the summer solstice (Blue: Homecenter; Orange: Parque botánico; Gray: Lider norte; Yellow: Jardines del sur; Green: Vivero; Calypso: Almagro)

However, the two places mentioned recently are within the urban part but represent cold microclimates within the city, so they serve as an example to study this phenomenon. As can be seen in figures 2 to 5, both sites register lower temperature degrees than other places, but what is most striking is the behavior of their trend, since there are periods where they rise and in others that go down, but not with a steep slope, and even, there are times where they remain almost constant. For this reason, it is possible to demonstrate the concept of heat island intensity.

3.2 ATMOSPHERIC TEMPERATURE

The records were compiled by datta loggers, which consist of temperature measurement devices. These artifacts are under the FONDECYT project: "Evidence of climate change in urban centers of Chile: Implication on natural risks and adaptive capacity". It is worth mentioning that the data collection performed by the instrument is hourly for all days of the year. For this investigation, the values of the temperatures were acquired thanks to the person in charge of the study in question, where 6 sectors of interest were chosen: UCN, Puerto, Ferrocarril, Casa Norte (located in the Jardines del Norte), Vivero Municipal and the Airport.

The datas that was collected dates from October 2010 to May 2017. However, there is a gap in the record of atmospheric temperature between the months of April to August 2015 due to a failure in the devices measurement.

What was done in the first instance for the analysis of the research, was to take weekly fragments of the sectors with respect to dates where the equinoxes and solstices of each year occur, more specifically, between days 18 to 24 of the corresponding months.

Then, 4 graphs are presented as examples that represent each of the periods (equinoxes and solstices) in 4 different years, mostly to get an idea of how the atmospheric temperatures of the 6 selected sectors have varied. It should be clarified that the x axis corresponds to time, where the divisions represent the first hour of the days, while the y axis is the recorded temperature.

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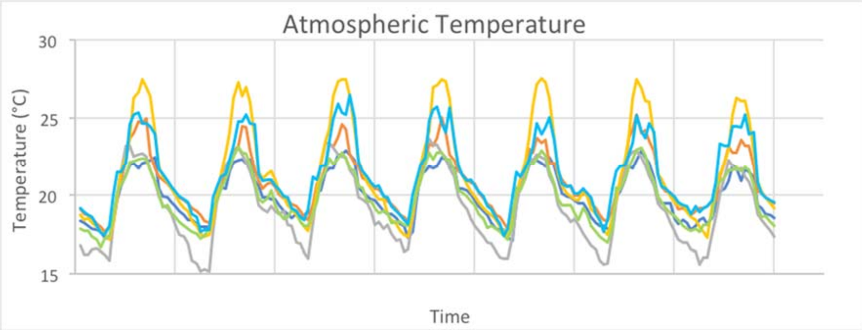

Fig. 6 Recorded behavior of the atmospheric temperature in the 6 stations during the weekly period of the autumn equinox (2011) (Blue: UCN; Orange: Puerto; Gray: Airport; Yellow: Casa norte; Green: Vivero; Calypso: Ferrocarril)

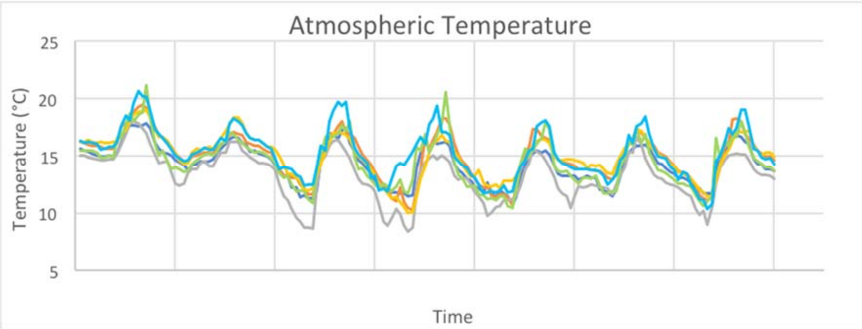

Fig. 7 Recorded behavior of the atmospheric temperature in the 6 stations during the weekly period of the winter solstice (2013) (Blue: UCN; Orange: Puerto; Gray: Airport; Yellow: Casa norte; Green: Vivero; Calypso: Ferrocarril)

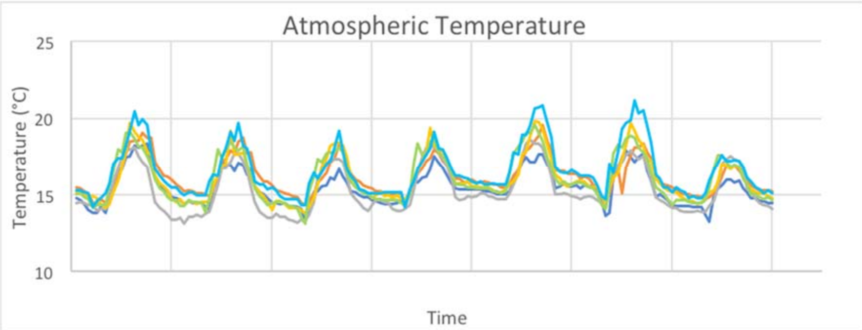

Fig. 8 Recorded behavior of the atmospheric temperature in the 6 stations during the weekly period of the spring equinox (2014) (Blue: UCN; Orange: Puerto; Gray: Airport; Yellow: Casa norte; Green: Vivero; Calypso: Ferrocarril)

As can be appreciated with the presented graphs, the behavior of the temperature in each one of the sites can be totally relative, since there are moments in which certain stations can present higher degrees of temperature, but in other occasions they can be below the other. However, a characteristic pattern can still be detected, in which it consists of a hypothetical order from highest to lowest of the stations that register the

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highest temperature indexes. Regarding this point, clearly the area of the Ferrocarril and the Casa norte are the ones that lead this assumption, then the Puerto follows and then in a balanced way the stations of the UCN and the Vivero municipal, to finish with the Airport which is the site that collect the lowest temperatures. As for the surface temperature, here too the heat island intensity effect can be demonstrated. Since both the Airport (rural area) and the Vivero (cold microclimate) have lower temperatures than those of the other sites (rural area).

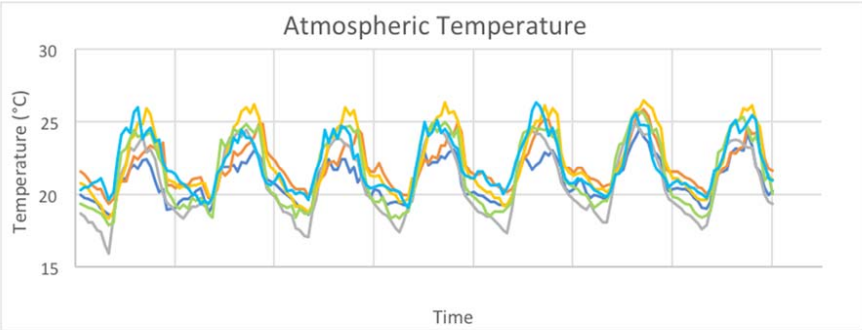

Fig. 9 Recorded behavior of the atmospheric temperature in the 6 stations during the weekly period of the summer solstice (2016) (Blue: UCN; Orange: Puerto; Gray: Airport; Yellow: Casa norte; Green: Vivero; Calypso: Ferrocarril)

3.3 RELATIONSHIP BETWEEN SURFACE (T_S) AND ATMOSPHERIC TEMPERATURE (T_a)

It was decided to study what type of relationship exists between the Ts with respect to the Ta, to discover that so much difference exists in the results obtained for both temperatures.
The same procedure was repeated again to calculate the Ts of the sectors that have record of the Ta, to exception of the Vivero, since it is the only place where all the values are held. However, there is something important to remember, is that the analysis of the Ts was dependent on the time the image was captured by the satellite sensor, which passed with minutes of addition, unlike the Ta, where the datta logger reported the data at just hours (without minutes). Therefore, it was decided to compare the hours that were used to determine the Ts, which were mentioned in Tab. 1 - 2, along with the hours closest to these that have information for the Ta, where obviously both come from the same date. Once the hour criterion has been clarified, a graph with the data of all the stations is presented below, to see what relationship exists between both temperatures. With the presented scheme, can check the demarcation that exists between each season of the year. It is easy to see how the periods are grouped in specific areas of the graph, where the lowest records correspond to those of the winter solstice (square), followed by the spring equinox (triangle), autumn equinox (circle) and finally with the highest values of the summer solstice (diamond), which is totally related to what happens in reality. On the other hand, it can be seen that the values corresponding to the Airport (purple) have a certain difference with respect to the other sites, since on average it achieves high levels of Ts, but low in Ta, giving similarity to what happens with a space rural desert, that is, the surface envient retains the heat coming from the sun, but the ambient is cooler, due to the great influence of air that is not hindered by large buildings.

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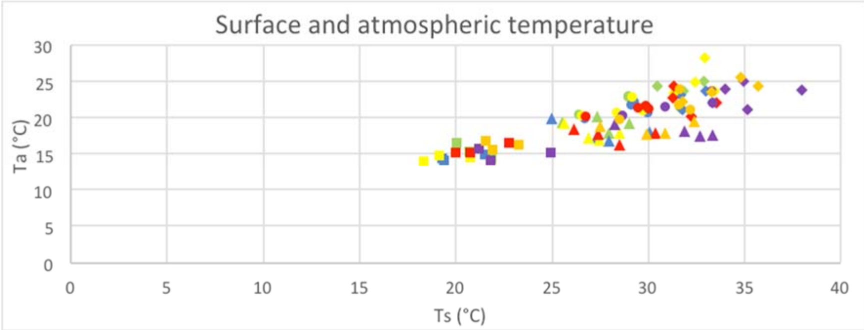

Fig. 10 Relationship between both temperatures with respect to the records obtained for each site and period (equinoxes and solstices) (Blue: Puerto; Orange: Ferrocarril; Purple: Airport; Yellow: Casa norte; Green: Vivero; Red: UCN). (Circle: Autumn equinox; Square: Winter solstice; Triangle: Spring equinox; Rhombus: Summer equinox)

The other sites, being installed internally in the city of Antofagasta (urban area), show a mixture between them in the location of the graphic, making it impossible to differentiate as it happens with the Airport. A very particular relationship is fulfilled, in the case of the Ts, the records vary in their entirety, within the range of 20°C to 35°C, while the Ta, does it within the range of 15°C up to 25°C. These values can be expressed in a mathematical relationship, which is associated with the equation of the line and is the one presented below:

$$\frac{T_a}{T_s} = \frac{(25-15)°C}{(35-20)°C}$$

$$\frac{T_a}{T_s} = \frac{10}{15}$$

$$T_a = \frac{2}{3} * T_s$$

For the analysis of the surface temperature, 6 sites of interest were chosen, which were represented in figure 4, where the evolution of the differences in the average surface temperatures of each place with respect to the city of Antofagasta was subsequently studied. where said results were reported enters Tab. 13 to 16. Then, these data will be used to determine the difference of average atmospheric temperatures through the presented equation. The sector of the Parque botánico and Lider norte within the autumn equinox period will be taken as an example to check how the trends between both temperatures vary.

AVERAGE TEMPERATURE (°C)

DATE	Ts (Parque botánico)	Ta (Parque botánico)	Ts (Lider norte)	Ta (Lider norte)
21-03-2014	-0,2440	-0,1626	-0,1069	-0,0712
08-03-2015	0,9637	0,6425	0,1623	0,1082
26-03-2016	1,7447	1,1631	0,9243	0,6162
29-03-2017	1,3059	0,8706	0,8685	0,5790
16-03-2018	1,5335	1,0223	1,4391	0,9594

Tab. 3 Registration of the Ta through the formula proposed for the sector of the Botanical Park and the North Leader

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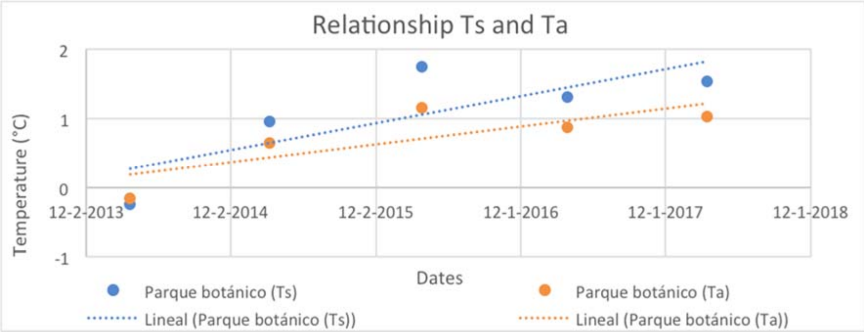

Fig. 11 Comparison of the trend for both temperatures in the sector of the Parque botánico during the autumn equinox

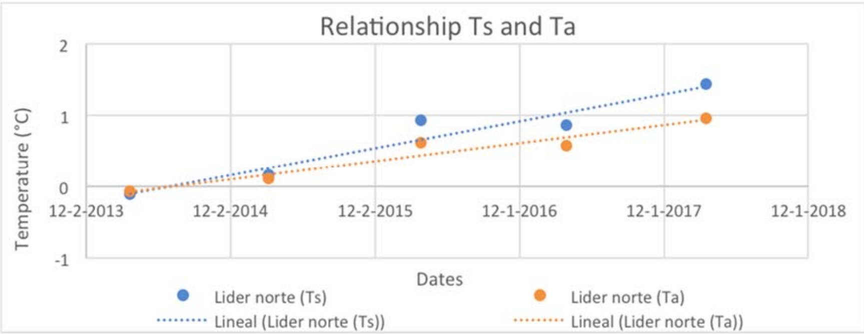

Fig. 12 Comparison of the trend for both temperatures in the sector of the Lider norte during the autumn equinox

In the presented graphs, it is clear that the tendency that represents the Ts has a steeper inclination than the one referring to the Ta. In the first case, it can be deduced that the Parque botánico has had a growth of the Ts with respect to the average temperature of the city of Antofagasta of approximately 1.5 ° C, while the Ta is of almost 1 ° C. With respect to the Almagro Buildings, both the Ts and the Ta register trends similar to the previous case, which are associated with the ratio of 2/3.On this occasion two places were taken as examples in the autumn equinox season, but it should be mentioned that the same effect occurs for all other sites in the different seasons.

4 CONCLUSION

Each one of the studies that were carried out to complete the research, contribute to the fact that a large part of the established hypothesis is fulfilled. With respect to the analysis of the surface temperature calculation with the ArcGis computer program, it clearly shows that, after the last 5 years, the average surface temperature of most of the areas examined in the different equinoxes and solstices have increased with respect to at the average temperature of the city of Antofagasta, where sites such as the Parque botánico have seen an increase of up to 3°C, Lider norte 2°C, Jardines del Sur 1°C, while Vivero has had a slight increase without exceeding 1°C still. On the other hand, the Homecenter with the Edificios Almagro have had varied behaviors, from eras with growth and others with decrease, but they are the ones that lead as the areas with the highest and lowest records respectively.

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With respect to the section of atmospheric temperature, a weekly fragment was taken to see the behavior of each of the sites in each of the seasonal periods, and it can clearly be established that urban areas detect warmer environments than rural ones (Airport) and green areas (Vivero municipal). Checking well, the impact generated by the intensity of the heat islands.

Finally, a relationship between both temperatures was obtained. As it could be demonstrated, if a place has had an increase of the Ts in these last 5 years with respect to the average temperature of the city of Antofagasta of 1°C, 2°C or 3°C, it will also have a growth of the Ta of 0,66°C, 1,33°C and 2°C respectively, since the criterion of 2/3 is met. This relationship is very important, as, thanks to this, future projections can be made and see which sectors of the city can be most affected to a possible climate change.

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THE PLACES AND TIMES IN RISK MANAGEMENT

THE CASE OF THE SCHOOL SYSTEM

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ABSTRACT

Natural risks in Italy are a problem to be faced in the life of every day, but the current instruments are not always able to plan and successfully manage the different phases that characterize them. As is known, the risk is a function of three variables: hazard, vulnerability and exposure. From the analysis carried out, the places and times that characterize every exposed are fundamental to consider. The aim of paper is therefore to deepen the exposure within the definition of risk. In particular, the approach introduces and quantifies indicators of different types, linked to characteristic aspects of a place and able to know the variation of the level of exposure to risk with time. Dynamic scenarios are defined temporally to plan mitigation actions in peace time and emergency. This model has been realized thanks to the interdisciplinary of urban planning with mathematic. A good indicator system is useful for helping to efficiently planning and allocates resources as well as monitoring the emergencies. The determination of a global exposure value, which brings together the individual indicators, also allows to define a hierarchy of priorities for the interventions to be implemented. Case study is the school system in the Savona city. The approach proposed, if applied also to the other settlement systems, would create a model for the definition of dynamic exposure scenarios. Therefore, the concept of temporality could be introduced within the Municipal Emergency Plans - made mandatory by L.100/2012-.

KEYWORDS

Risk Management; Places and Times Dynamic Exposure Scenarios¸Municipal Emergency Plans

1 INTRODUCTION

The safety of the territory from natural events is a priority issue at the Italian level. Looking at the last few years, sadly, several calamitous events are occurred in our regions, from hydro geological and alluvial events to seismic events. As is known, a natural risk can not be eliminated, but through policies, plans, instruments and coordinated actions, it can certainly be mitigated. The turning point can only take place when the perspective of approaching the problem of natural risk will be to face the extraordinary in the ordinary.
In fact, the actions aimed at reducing the risk "in the ordinary practices of government and intervention in the territory and the city plays a central role ... facing the issue of risk mitigation in a conscious and effective way, in conditions of ordinariness" (Caldaretti, 2002). Despite the repetition of disastrous events, this awareness has not yet entered into risk management policies. The urban Plans, different from region to region, do not has a guidelines at national level for this aspect . The issue of risk is therefore addressed in a discretionary way by the individual Regions. In Italy, there are then the Civil Protection Plans and instruments that addresses the issue of natural risk, but which does not interact with the urban Plans, which should obviously have a good knowledge of the territory, also in terms of safety in relation to of risk. Thanks to Law 100/12 "Provisions for the reorganization of civil protection", the Municipal Emergency Plans (PCE, introduced with the first Law relating to Civil Protection L. 225/92) become mandatory. In particular, the structure of a PCE includes: the analysis of the territory, the definition of local civil protection structures, the study of risk scenarios and the definition of intervention models. The expected risks, not only of a natural type, taken into consideration are: seismic, volcanic, meteorological-hydro-geological and hydraulic risks, fires, sanitary, nuclear, environmental and industrial risks. Within the Plan is introduced the instrument "risk scenario" need to know: what is happening and what will happen; what action to take to mitigate the damage and with what resources; which actions have priority over others; if and which resources need to be requested because they are not available immediately. The risk scenarios, according to recent legislation, are the result of a process of analysis and overlap of the data obtained from the exposed and hazard studies. The scenario must consist of a brief description of the event, accompanied by a cartography - related to the danger and / or exposure -. explanatory of the areas considered most at risk. The research described in the present paper is precisely inserted in this context. To address the extraordinary in the ordinary, as mentioned above, techniques and methods for creating knowledge capable of guiding policies, instruments and actions are necessary to have. In this perspective, the risk scenario is proposed as a cognitive tool to analyse the territory, including various settlement systems, in term of consistency and functions. "... the only way currently available to us is to work for scenarios, trying to project our knowledge on the current state and the probable predictions of how our actions will change the same state. The scenario must be considered as an instrument of analysis and verification" (Menoni, 1997). For Freire et al. (2013) "the urban landscape is endowed with projected visible dynamism, and is a product of human action that produces a superimposed palimpsest". Currently, the practice of spatial perception in daily life is superposed by the fast pace of big cities. For Lynch (1990), “the moving parts of a city, especially the people and activities, are as important as their physical properties and parts.” In this sense, "the development of technologies can facilitate the automatic understanding of objects and their surroundings" (Borges et al., 2014). The risk scenario, as is known, considers the natural risk as a function of three variables: hazard, vulnerability and exposure. In particular, the paper focuses on exposure – the territorial system considered – made up of the different settlement systems (school, health, ...) that vary their 'risk level' as time changes (hourly, daily, monthly, ..).

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In the functioning of a city, therefore, the two aspects places and times are interwoven. "The city conceived by temporal policies is a city of chronotopes, physical places of spatial and temporal architectures animated by rhythms of presence and coexistence of its citizens and temporary inhabitants" (Bonfiglioli, 1999).
"For a correct safety of the territory from natural events, in the study of the territorial system and its functional subsystems, as well as the related logics of interrelations, consider the concept of time is fundamental" ... "The time-based urbanistic approach is integrated well in the analyses aimed at the put in safety of a territory from natural events where the knowledge of the territory not of a static but dynamic type (Pirlone, 2009). The present research starts from the existing scientific literature, examining, in the context of the risk scenario tool, the places and times that characterize the exposed. The approach proposed in paragraph 1, which sees a first realisation (by way of example for the school settlement system in the city of Savona) reported in paragraph 2, would lead to the definition of a risk scenarios, no longer static but dynamic over time. These dynamic scenarios could be included in the municipal emergency Plans, made mandatory, as explained above, from L.100 / 2012. In particular they could have a double value: to be used to manage the emergency, but at the same time, under normal conditions, to plan the mitigation actions to be adopted for the purpose of safety against risks throughout the territory.

2 NEW APPROACH FOR DEFINING THE SCHOOL SYSTEM EXPOSURE IN THE CONTEXT OF THE CIVIL PROTECTION PLANS

The aim of paper is therefore to deepen the exposure within the definition of risk. In particular, the approach introduces and quantifies indicators of different types, linked to characteristic aspects of a place and able to know the variation of the level of exposure to risk with time. Dynamic scenarios are defined temporally to plan mitigation actions in: peace time (thus reducing the potential damaging effects of an event) and emergency (actions of coordination and rescues management). The scenarios thenrefore analyze the entire municipal territory this because "the involvement of the proximity context of the infrastructure opens up tempting opportunity to test strategies for urban regeneration that raising the quality of the adjacent spaces may also offer opportunities to mobilize private capital available to the perspective of sustainable urban development and socially cohesive" (Di Girolamo, 2016). A good indicator system is useful for helping to efficiently planning and allocates resources as well as monitoring the emergency situations. The approach considers also the determination of a global exposure index, which brings together the individual indicators. This global index also allows defining a hierarchy of priorities for the interventions to be implemented. These scenarios, which consider the introduction of specific indicators to the definition of exposure, will be the basis for new Civil Protection Plans. This model has been realized thanks to the interdisciplinary of urban planning with mathematic. Among the different settlement systems, the paper examines the school system. In order to carry out a qualitative-quantitative analysis, each indicator has been associated with exposure levels that must be checked and adapted to each analysed case. The indicators proposed for defining exposure of the school system and the corresponding range of values are five. They have been defined thanks to interviews with experts.
The first two indicators (which take into account the time factor) are:

- INDICATOR 1 - AGE: takes into account the age of the student population present within the considered educational institution and consequently their awareness of the danger and autonomy in the pre-emergency and emergency phases;

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- INDICATOR 2 - REFERENCE: refers to the maximum number of students present at the peak hour. This value is taken as a reference for the next calculation.

The evaluation of these first two indicators is through the definition of a database that needs to be constantly updated (Database 1, Fig. 1). For the structures analysed, this database must be compiled with the number of presence during precise intervals of time. In the case of the school system here investigated, the number of students and operators -teachers, janitors ..., in the different levels of school education, also varies substantially during the daily span. For monitor over time the presence of the population exposed to risk is therefore considered important discretize the day in intervals of half an hour. In addition, to examine the different times of presences / lessons (which is not said to be the same every day, think for example on Saturdays and Sundays) and closing days is essential to consider the presences during the days of the week, in the different months of the year.

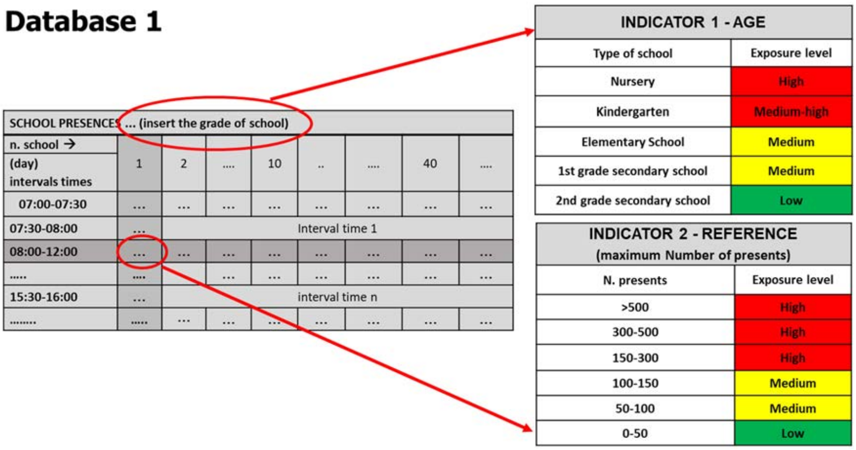

Fig. 1 Database 1 for the collection of data on the presences and the determination of 1 (age) and 2 (reference) indicators

The subsequent indicators provided by the methodological approach refer to the time that the emergency vehicles would employ to reach the exposed structure (calculated on the shortest path), they are:

- INDICATOR 3 - PATHS: attributed on the basis of the number of paths that allow the main relief providers (Croce Rossa, Fire fighters, Civil Protection Department, Hospital ...) to reach the school in a short time. It is important to underline that 4 school-rescue organization links were taken into account, but in any other application this value could be changed according to the available services;
- INDICATOR 4 - LOCALISATION: linked to the location of the considered structure respect to the morphology and the centrality of the same in the urban system;
- INDICATOR 5 - ALTERNATIVE/ACCESSIBILITY: assumes values equal to 1, in the case in which there are no alternative paths for reaching the school and assumes a value of 0, when there are more roads leading to the school in question.

For the calculation of afore mentioned times is important to consider any building sites, or possible slow-down or blocking situations, that the calamitous event could generate. For the quantification and calculation of these

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indicators, a study on the location of the school structure analyzed is required and a second database containing all the useful information was created (DATABASE 2, Fig. 2).

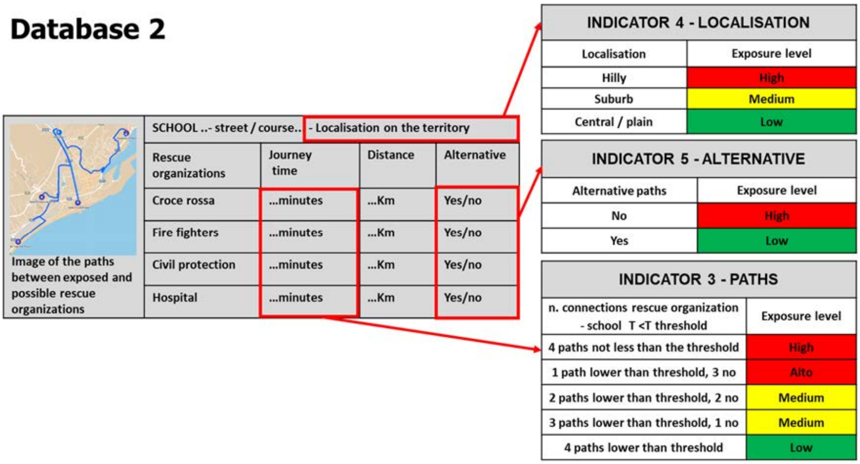

Fig 2 Database 2 referring to the localisation and distances between rescue organizations and schools for the calculation of the 3 (paths),4 (localisation) and 5 (alternative) indicators

The approach therefore provides, a first phase of the compilation of the elaborated databases (1 and 2) with the quantification, for each exposed considered, of the 5 indicators. Having identified the most critical time intervals from DATABASE 1, starting from indicator 2, a new indicator is calculated, called reference indicator 2, assigned to the maximum number of presences (Fig. 3). Subsequently, the global exposure index is introduced, which considers the combination of the five indicators defined above (Fig. 3). This is an algebraic algorithm that combines in a weighted way the described indicators providing a final value between 0 and 1.

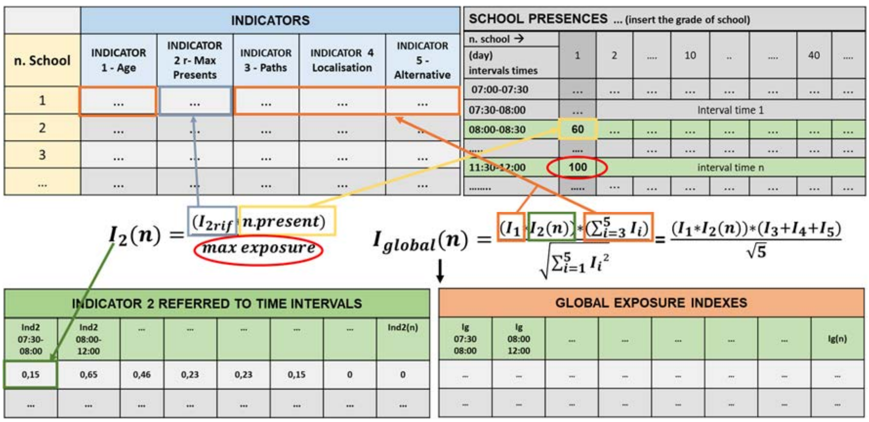

Fig 3 Temporal exposure calculation

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The global index considers the sum of the specific global indexes for the different intervals, allowing a depth analysis of the school structure under study. The methodological approach also includes the mapping of the various indicators, so as to identify the situations most at risk and therefore, for them, propose solutions that reduce exposure. These mappings are fundamental to subsequently evaluate the global index and thus have a total situation mapping. The exposures scenarios obtain are no longer static but dynamic over time and taking into account the characteristics of the places of the considered exposures. The methodological approach developed should be considered within the new Municipal Civil Protection Plans. For a better management in the Plan, a graphical interface to be used is proposed. In this specific case, through the use of Matlab, an interface for the school system has been defined (Fig. 4).

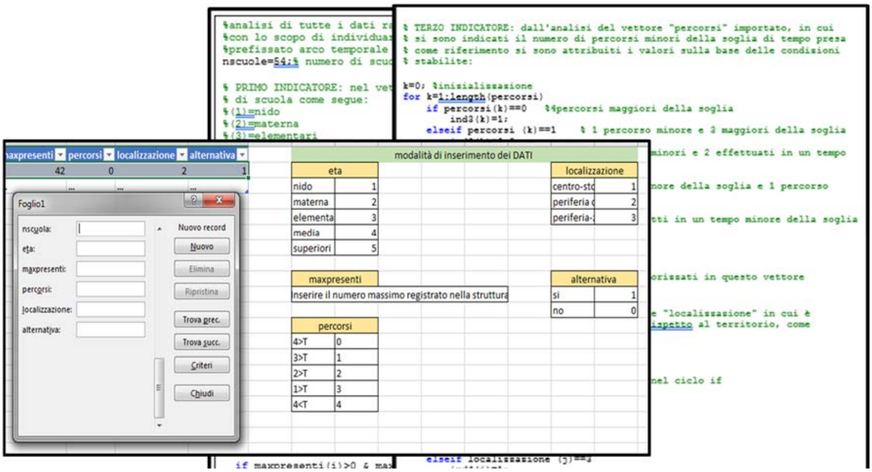

Fig.4 School system interface

By inserting the data characterizing the school into the two databases (1 and 2), the defined instrument (interface) directly provides the value of the global exposure index. This global index allowing to have immediately a daily view of the variation of exposure at risk (Fig. 5).

3 FIRST APPLICATION TO THE SAVONA SCHOOL SYSTEM

Among the different settlement systems, as described in paragraph 1, in the paper the school system is deepened. A first application of the proposed approach is carried out in the city of Savona.

The Municipal Territory of Savona, a provincial capital city, is located in the coastal area of the western Ligurian Riviera. The territory has an extension of 65 km^2; fractions develop in hilly / mountainous areas while the urban and suburban centers in the plains. Savona has a densely urbanized territorial structure, particularly in the plain area consisting of an alluvial plain of the Letimbro stream and along the sea front. In this area there is about 80% of the buildings, which is the main urban center of Savona. Over the centuries, the urban center has progressively expanded in the area of the commercial port both from the point of view of the building and from the infrastructures that serve it. Immediately near the harbour dock there is the historic center.

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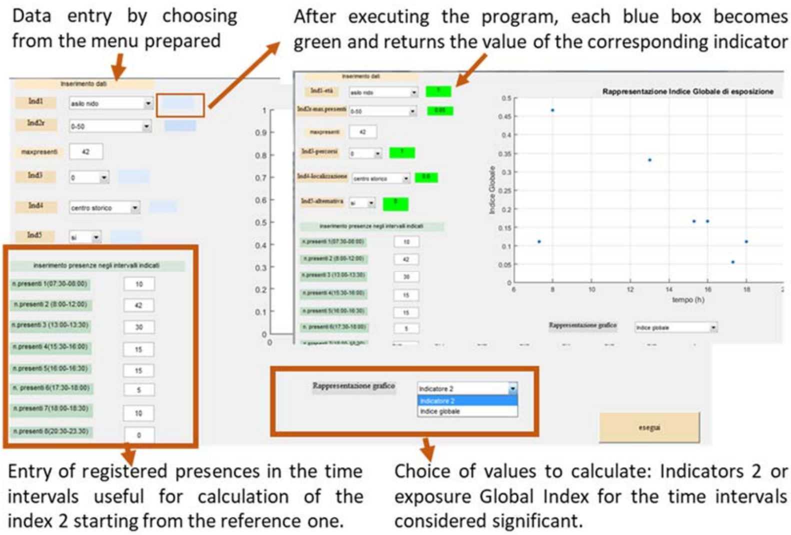

Fig.5 Graphical interface for the calculation of the Global Index

Analysing the current Municipal Emergency Plan of Savona, it emerges that the territorial analysis was carried out to highlight areas subject to various risks such as:

- hydro-morphological-geological risk;
- fire risk;
- seismic risk;
- risk from exceptional meteorological events;
- industrial and technological risk;
- risk deriving from transport on aircraft, road or rail and emergency at sea.

Regarding the school system, analysed in the paper, the current Municipal Emergency Plan of Savona (section 4.4.1 "Evacuation - General Procedures") in the event of critical hydrogeological / hydraulic issues defines: in the time of non-operating school facilities, the closure of all public and private schools or educational institutions, of any order and degree; in time when the schools are operational, all those present must remain there until the communication of "endangered danger" by the Authorities. If the subjects are in a building located in a floodable area they must move to the upper floors in safe areas and follow the procedures described in detail. The individual schools should know and follow these instructions and self-protection measures set by the Department of Civil Protection. Wanting to insert the new methodological approach in the Civil Protection Plan of Savona, in a first phase, in order to compile the database 1, all the schools (of different order and degree) in the Savona territory have been identified and numbered in progressive order. Subsequently, the presences of each single school were reported taking as reference the times of a typical week, marking the days in 30-minute intervals, so as to record with greater detail the variation of the exposed vulnerable. Through the use of an excel tool (Power Map) were made three-dimensional maps. These maps make possible to identify which school - at a time and place specific - have a greater number of exposures - in terms of number - and how they are distributed throughout the territory (Fig. 6).

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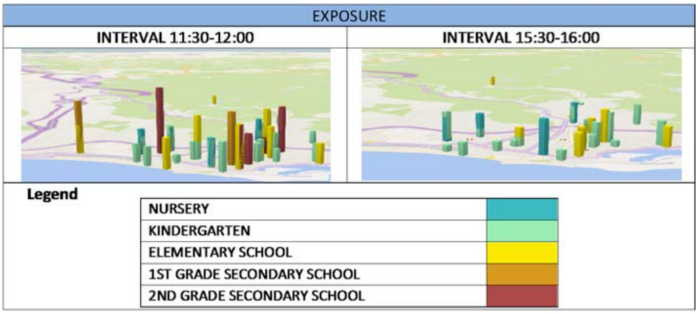

Fig. 6 Examples of representation of the number of people present in the Savona area

In order to compile the database 2 for the study of school-rescue links, local rescue personnel were identified and located. For each school, the shortest path was then analysed, verifying the possibility of alternative paths, if the main one was not practicable. The municipal territory was then divided into three homogeneous zones: center, suburb, hill to take into consideration the location with respect to the center. Once the data - in terms of attendance and localization - necessary for the compilation of the first two databases was obtained, the 5 indicators identified in the approach were calculated. According to the classifications - high, medium, low - described in the methodology, an initial analysis was performed on the levels of each indicator. In Fig. 7 the relative quantifications are shown. Still using the Excel tool (above mentioned), each indicator has been mapped with the purpose of analysing the individual indicators and evaluating them according to the territorial and temporal distribution.

SCHOOL N°	INDICATOR 1 (Age)	INDICATOR 2 (Reference)	INDICATOR 3 (Paths)	INDICATOR 4 (Localisation)	INDICATOR 5 (Alternative)
1	High	Low	Medium	Medium	Low
2	High	Low	Medium	Medium	Low
3	High	Low	Medium	High	Low
4	High	Low	Low	High	Low
……	……	……	……	……	……
49	Low	Medium	Medium	Medium	High
50	Low	High	Medium	Low	Low
51	Low	High	High	Low	Low
52	Low	High	Medium	Low	Low
53	Low	High	High	Low	Low
54	Low	High	High	Low	Low

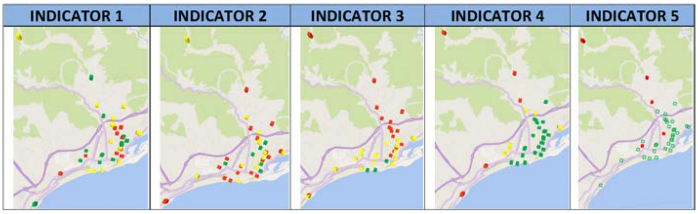

Fig.7 Indicators 1, 2, 3, 4, 5 for the Savona school system: qualitative analysis

The next phase concerns the quantification of the global index value in the time intervals considered.

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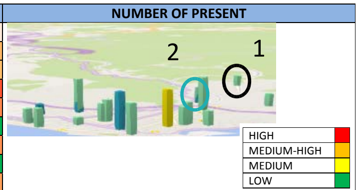
This phase shows the times when the risk exposure is greater and therefore what are the structures that need help in the emergency phase, but also in periods of peace to be able to reduce these levels of exposure in case of occurrence of an event. Starting from these values, for the considered temporal discretization, exposure scenarios for each single school is realized. Some considerations emerge from the analysis of the results obtained. Take for example the time interval between 7:30 am and 8:00 am on Monday, in Fig. 8 are shown the data and the representations - obtained through the power map - related to the presences and the global index calculated for the schools from Savona. Both graphically and in tables, in some cases, there is a strong difference in the value of the global index for the same number of exposed. In case 1: schools with 20 present are analyzed. The global index is very different. In fact, while for schools 7, 19 and 20 the index is a value between 0.15 and 0.25, for school 18 the index has a value of 0.55, so very high compared to the average. In case 2: schools with 25 present are analyzed, only school 6 has a very high global index value while the others take a value between 0.18 and 0.26.

MONDAY (INTERVALLO 07:30-08:00)		
SCHOOL N°	n. presents	Ig
1	10	0,12
.....	.....	.....
6	25	0,36
7	20	0,24
8	0	0,00
.....	.....	.....
13	0	0,00
14	25	0,18
15	50	0,28
16	25	0,26
17	25	0,18
18	20	0,55
19	20	0,24
20	20	0,20
21	25	0,21
22	20	0,15
.....	.....	.....
54	0	0,00

NUMBER OF PRESENT



GLOBAL INDEX

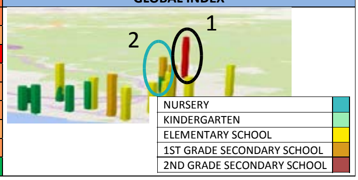


Fig. 8 Comparison between exposure referring to number of present and to global index

The results of this first application show the importance of the factors introduced in the approach presented: age of the subjects, position of the structure on the territory, ability to reach the school with the means of rescue. In fact, in an analysis of risk exposure it is not enough to consider only the number of those present, but a more in-depth analysis is required. The application of the approach ends with the proposition of some mitigation actions that can reduce the level of exposure by acting on the individual indicators proposed such as the increase of educators in kindergartens, the possible relocation of schools or emergency services, infrastructural interventions on roads. The proposed approach is therefore a new tool to be included in the Civil Protection Plans. The knowledge of the individual indicators and the global index can be useful to plan and correctly manage the different phases of risk, starting from prevention, emergency, post-emergency and reconstruction. The approach taken for the school system, if applied also to the other settlement systems, would lead to the realization of a global model at a territorial level for the definition of dynamic risk scenarios. The introduction of such time scenarios within the Municipal Emergency Plans (mandatory from L.100 / 2012), allowing a greater knowledge of a territory, become a fundamental tool in ordinary time, to plan mitigation actions in order to make an area increasingly resilient to natural events.

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ANNEX

Francesca Pirlone: the author has edited paragraph 1 and paragraph 2 in collaboration with I. Spadaro.

Ilenia Spadaro: the author has edited paragraph 3 and paragraph 2 in collaboration with F. Pirlone.

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DISTRIBUTED DELAY MODELS

A PROPOSAL OF APPLICATION IN URBAN CONTEXT TO FORECAST PEST INSECTS' LIFE CYCLE

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ABSTRACT

Talking about Integrated Pest Management it is common to think about an agronomic context. In this case the technology has gone ahead, providing a large series of instruments of different type. Precision farming, for example, will allow to build always more accurate machines to inspect plants and remove pest insects. To help agronomists and technicians, furthermore, is going ahead the idea to develop always more raffinate mathematical models to describe insects and plants lifecycle, in relation to environmental parameters such as the daily average temperature. A good model for this purpose is the Distributed Delay Model, enriched in the course of time with much more mathematical aspects.The aim of this work is to present a new modeling approach developed on two different sides: the first one is by the mathematical side, with a new develop of Von Foerster's equation, and the second is the implementation of the equations in a software built with the ROOT libraries and C++ programming language. A new mathematical form for the Von Foerster equation allows to insert directly in the model all the parameters related to environment and the specie. Through the use of the upwind method, this partial differential equation can be solved with an implementation in a dedicated software. The DS Simulator is the final product, a software composed of a list of macros able to accompany the environmental scientists since the first step of parameters estimation in laboratory. In the specific, in the metropolitan area of Rome, our purpose is an application in the case of Rhynchophorus ferrugineus and Lobesia botrana.

KEYWORDS

ROOT; Forecasts Urban Pests; IPM Plant Protection

1 INTRODUCTION

In an urban context, always more attention is given to the green areas. In much cases, they represent a real distinctive factor, which add value to the livability. The role of green areas, in fact, is marked not only by the citizens who decide to spend there their free time, but also by the public authority which organize social programs. A green area plays a fundamental role in the concept of a modern city, represents a complement to its beauty, to arise its biodiversity and often is a solution to recover abandoned areas. However, the introduction or the maintenance of parks and gardens leads a series of problems related to the ecosystem health. The lack of knowledge about entomological problems related to the urban plant species allowed the increase of infestation by autochthonous phytophagous and the introduction of a wide series of alien species. A recent example concerns about the case of the red palm weevil Rhynchophorus ferrugineus (Oliver) in Italy, and in particular in the metropolitan area of Rome as case study. The first introduction of the palm weevil in Europe has been verified in the south of the Spain in the past 1994 through the importation of ornamental palm species (Phoenix spp.). Ten years later, Longo and colleagues. (Longo, 2006; Longo et al., 2011) confirmed the presence also in Italy, starting from Toscana, and then forwarding in Campania, Sicilia and Lazio. Actually, in the metropolitan area of Rome R. ferrugineus represents a problem for private gardens and public parks, not only due to the plant diseases, but also for the public safety. In fact, females lay eggs in the palms' crown, above all in exemplars still damaged by wrong pruning, other insects or climatic agents (Speranza et al., 2007). The red palm weevil feeding activity causes a slow weakening on the trees, until the leaves' or crown crash. On the other hand, the metropolitan area of Rome presents a high density of farms, above all in its outskirts. The presence of an agricultural context merged with an urban reality, requires to not neglect entomological problems related to the main cultures. More specifically, Rome's suburbs are featured by a high-quality wine production, such as Frascati Protected Denomination of Origin (DOP), olive's oil production, sheep and cattle pastures. It's totality, represents a crucial cropping system to preserve natural resources and environmental quality (Brunori et al., 2016; Ferrara et al., 2016). Concerning grapevine and olive's trees, the related main entomological problems are due to the grapevine moth Lobesia botrana (Denis & Schiffermüller) (Severini et al., 2005) and to the olive fruit fly Bactrocera oleae (Gmelin) (Baratella et al., 2017; Pucci et al., 2013; Pucci & Spanedda, 2006; Speranza et al., 2004). The restricted European and national regulation about the pesticides use, and the nearness to an urban area induced entomologists and IPM scientists to consider as a driving factor the role of monitoring and modelling to optimizes the control strategies. The aim of this work is to focus the attention on the role of mathematical models to describe pest insects' lifecycle, providing work hypothesis based on the existing literature and on our new developments in this scientific area.

2 MATHERIAL AND METHODS

Mathematical models represent a helpful tool concerning the forecasts in Agriculture. Historically, are divided in *Phenological Models* and *Demographic Models* (Severini et al., 1990), but the most widely used are a branch named *Distributed Delay Models*. The success of these last is due to the capability to include in a demographic description the environmental parameters. This means that after a session of parameters estimation through laboratory experiments, and a following validation with field data, their application can be carried out in different environments. Several works (Galeano-Vasco et al., 2013; Gutierrez & Baumgärtner, 1984; Gutierrez & Pizzamiglio, 1984; Limonta et al., 2009; Pesolillo et al., 2004) show different application of the most famous

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Distributed Delay Model, the one introduced by Manetsch (Manetsch, 1976) and performed by Vansickle (Vansickle, 1977) with the addition of a mortality coefficient. Its mathematical is the following:

$$\begin{cases} \dfrac{d}{dt}Q_1(t) = \dfrac{h}{D(t)}\,Q_0(t) - Q_1(t)\left[\dfrac{h}{D(t)} + M(t)\right] \\ \dfrac{d}{dt}Q_2(t) = \dfrac{h}{D(t)}\,Q_1(t) - Q_2(t)\left[\dfrac{h}{D(t)} + M(t)\right] \\ \qquad\vdots \\ \qquad\vdots \\ \dfrac{d}{dt}Q_h(t) = \dfrac{h}{D(t)}\,Q_{h-1}(t) - Q_h(t)\left[\dfrac{h}{D(t)} + M(t)\right] \end{cases} \tag{1}$$

where $Q_i(t)$ represents the number of individuals in each stage, $D(t)$ is the average developmental time, $M(t)$ is the intrinsic mortality coefficient and h is a variability parameter to be estimated in phase of calibration with field data (Severini et al., 1990). The chained ordinary differential equations system (1) allow to describe the distribution of developmental times of an insects' cohort, but apparently it does not contain environmental and specie parameters. For the applications, is usual to consider the following expression (Severini & Gilioli, 2002):

$$R[T] = \frac{1}{D(t)} \tag{2}$$

which provide the relationship between the average developmental time $D(t)$, and the development rate $R[T]$ in function of the temperature T. The introduction of expression (2), brings conspicuous advantages. In the course of time, in fact, several authors reported empirical and non-empirical laws to express the changes in developmental rates as the temperature arises. The most common are:

- linear rate function (Severini & Gilioli, 2002):

$$R[T] = \frac{1}{S}(T + T_L) \tag{3}$$

where S is the thermal summation, and T_L the lower threshold for the thermal development range;

- Briére rate function (Briere et al., 1999):

$$R[T] = a(T - T_L)(T_M - T)^{\frac{1}{m}} \tag{4}$$

where a and m are empirical parameters, T_L and T_M are respectively the lower and higher thresholds for the thermal development range;

- Logan rate function (Logan et al., 1976):

$$R[T] = \psi\left[\exp(\rho T) - \exp\left(\rho T_M - \frac{T_M - T}{\Delta T}\right)\right] \tag{5}$$

where ψ and ρ are empirical parameters, T_M is the higher threshold for the thermal development range and $\Delta\, T$ is the T-interval length from the maximum peak of the function, and T_M;

- Sharpe and De Michele rate function (Sharpe & DeMichele, 1977): to date, this is the only rate function based on thermodynamics laws, and not empirical

$$R[T] = \frac{T\exp\left(A - \frac{B}{T}\right)}{1 + \exp\left(C - \frac{D}{T}\right) + \exp\left(E - \frac{F}{T}\right)} \tag{6}$$

where A, B, C, D, E, F are parameters related to thermodynamic functions. For any further information about Sharpe and De Michele rate-function, the reader is referred to the reported literature.

The choice of the most appropriate rate function usually depends on the utilizers' background. The common feature is that all the expressions need a non-linear fit operation for parameters estimation. In an experimental context, a cohort of insects is reared in climatic cells at different constant temperatures, and the mean developmental time D is calculated. The conversion between times and rates is carried out through the

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expression (2), obtaining the needed plot $T - R[T]$. In most cases the rearing operation require long time and suitable equipment, and the number of explored temperature usually can influence the choice of the rate function. By the way, Logan, Briére and linear are the widely used expressions. Another question to point out concern the driving variable. The development of a poikilothermic organism is not influenced only by the temperature T, but also by humidity and photoperiod which usually influence the microclimate inside the host plants, and the diapause mechanisms. Despite this approximation, several works showed, during the years, that considering the temperature as the only driving variable have provided good results for poikilothermic organisms. The Manetsch's Distributed Delay Model (1), is therefore completed with the insertion of one of the rate functions between (3), (4), (5), (6), and represents a complete tool, if inserted in a calculation software.

2.1 CALCULATION SOFTWARE: THE INTRODUCTION OF ROOT

Concerning the simulation process, there is not a wide literature about which is the best software to be used with distributed delay models. The ideal software should be open source, versatile, and able to follow each phase from the parameters estimation to the field validation. The research groups, in fact, employ a conspicuous part of the economic resources to develop, with external companies, simulation platforms, and most of them are protected by a license. The costs could affect the possibility of new contribution from the smaller research groups and from all the universities with limited budgets. For this reason the choice is to introduce a different application of ROOT, a software born by a CERN project started in 1994 by René Brun (Brun & Rademakers, 1997) to build a series of macro able to follow entomologists, ecologists and IPM scientists during all the process involved in the use of the distributed delay models. ROOT, is "a modular scientific software framework. It provides all the functionalities needed to deal with big data processing, statistical analysis, visualization and storage. It is mainly written in C++ but integrated with other languages such as Python and R" (https://root.cern.ch). It is widely utilized in the main field of Physics, and during the last years have found new applications in Economy and Engineering. There are no applications reported in Agriculture, but for simulation processes is highly recommended. One of the points of force is the choice to use two common programming languages, C/C++ and Python to build macros in which can be called a large series of mathematical and statistical functions included in ROOT's libraries. This mean that it is not required a wide knowledge of programming language to pursue our goals. In the following sections, are showed some results.

2.2 GENERALIZED VON FOERSTER EQUATION

The Manetsch's Distributed Delay Model (1), introduced in the section (2), represents a discrete form of an age-structured model. One of the limits concerns the fact through which the lifecycle is considered composed by a series of equal chained stages. Von Foerster (Von Foerster, 1959) proposed a different model able to describe an age-structured population. The advantage regards the possibility to describe the dynamic of a population which evolves in chronological time (t) and chronological age (a). Mathematically is represented by the following well-posed problem:

$$\begin{cases} \dfrac{\partial}{\partial t} n(a,t) + \dfrac{\partial}{\partial a} n(a,t) = -M(a)\, n(a,t) \\ n(0,t) = \displaystyle\int_0^{\infty} \beta(a,t)\, n(a,t)\, da \\ n(a,0) = n^0(a) \end{cases} \tag{7}$$

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where $n(a,t)$ represents the population's density, $M(a)$ is the mortality relied on the age, $n(0,t)$ is the boundary condition which provide the newborn regulated by the fertility function $\beta(a,t)$, and $n(a,0)$ is the initial condition. A different version, could be presented including directly in the partial differential equation (7) the rate function $R[T]$, starting from considerations introduced by Di Cola et al (Bellagamba, Cappio Borlino et al., 1991; Di Cola et al., 1987; Di Cola & Gilioli, 1996). The modified Von Foerster equation is based on the concept of physiological age, x, different from the described chronological age a: the first is a variable which describe the intrinsic maturation process, while the second is a time with different scale. In formulas, the description is resumed as:

$$\begin{cases} \frac{\partial}{\partial t} n(x,t) + \frac{\partial}{\partial x} R[T]\, n(x,t) = -M(x)\, n(x,t) \\ n(0,t) = \int_0^\infty \beta(x,t)\, n(x,t)\, da \\ n(x,0) = n^0(x) \end{cases} \tag{8}$$

The equation (8) can be worked out numerically through the upwind method (Bellagamba et al., 1987; Di Cola et al., 1989) and provide a system of ordinary differential equations similar to Manetsch's system (1) (Plant & Wilson, 1986). Through the use of ROOT, it is possible to include in a dedicated macro the discretized model, and this will be the kernel of our proposal to forecast *L. botrana* and *R. ferrugineus*' lifecycles in urban context.

2.3 PARAMETER ESTIMATION

A simulation process begins with a laboratory phase, in which are conducted a series of experiments in climatic cells. More specifically, it is built a cohort of insects with eggs laid all on the same day, left singularly in Petri dishes and stored at constant temperature. The lifecycle is followed with daily checks, and for each individual is reported the daily stage. At the end, will be possible to calculate the average developmental time D, specific for the temperature of rearing. The next step regards the conversion of the times in rates, followed by a non-linear fit with the described rate functions to estimate the related parameters. In the case of L. botrana and R. ferrugineus, there are two works which report the life tables (Li et al., 2010; Moshtaghi Maleki et al., 2016). More particularly, for L. botrana it is possible to calculate the parameters of linear, Briére and Logan rate, while for R. ferrugineus only the linear is allowed by the data.

The reason is due to the fact that Briére and Logan rate functions require at least 5 experimental points and Sharpe & De Michele at least 6 of them. Furthermore, to obtain a good fit, laboratory data have to show the typical increasing-decreasing shape. Data from Li et al. satisfy the first condition, but not the second and the software cannot calculate functions outside the linear case. To pursue the linear and non-linear fitting process has been built a macro called "fittasso.c". Its task is to take in input the experimental data from a .txt file, and to return the fit parameters and their associated errors both in graphical and textual way. Fit results are reported in Table 1 and Fig. 1 concerning L. Botrana, in Tab. 2 and Fig. 2 for R. Ferrugineus. Regarding the Lobesia botrana case, there are three rate functions available. For a good simulation, is better to not consider the linear case. The choice is due to the R^2 value, reported in Tab. 3.

Not considering the linear case, a good strategy is a combined use of both Logan and Briére rate functions: the first one tends to describe better the experimental points in a higher temperature range, while the second gives information about the lower temperature range, and for this way is more appropriate. These considerations will be treated in the section 3, in which will be shown a perspective of application.

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Briére rate-function (4) fit results	Logan rate-function (5) fit results	Linear rate-function (3) fit results
$a = (331 \pm 8) \cdot 10^{-7}$	$\psi = (7 \pm 1) \cdot 10^{-4}$	$\frac{1}{S} = (132 \pm 7) \cdot 10^{-5}$
$T_L = 6.6 \pm 0.7$	$\rho = 0.16 \pm 0.01$	$\frac{T_L}{S} = -0.013 \pm 0.002$
$T_M = 33.0 \pm 0.1$	$\Delta T = 4 \pm 3$	
$m = 4.85 \pm 0.5$	$T_M = 33.9 \pm 0.8$	

Tab. 1: Non-linear fit parameters estimated with fittasso.c macro for *Lobesia botrana* rate-functions. Data for the fits are from Briére (Moshtaghi Maleki et al., 2016)

Linear rate-function (3) fit results
$\frac{1}{S} = (62 \pm 2) \cdot 10^{-5}$
$\frac{T_L}{S} = -0.0107 \pm 0.0007$

Tab. 2 Fit parameters estimated with fittasso.c macro for Rhynchophorus ferrugineus rate-function. Data for the fits are from Li et al. (Li et al., 2010)

Rate function	R^2 value
Linear	0.854
Logan	0.964
Briére	0.925

Tab. 3 R^2 values related to L. botrana rate functions. The reported values show that the linear rate function is not a good choice for a simulation for this case

3 PERSPECTIVES OF APPLICATION

The phase of parameters estimation has been defined as a laboratory phase. In this section will be shown a proposal of simulation through the use of the generalized Von Foerster equation. Using the ROOT's libraries, included in a C++ macro, has been developed a macro called simulatore.c which contain the discretized system (8). This macro gives in input a vector (involved in a .txt file) with the average daily temperatures, calculated through the use of a meteorological station or a data logger. Daily temperatures will be used to estimate the rate function $R[T]$ in the partial differential equation: there is not a different way to proceed, because to date there is not a specific function able to describe the daily temperature in function of the time. Hence, a numerical solution is required. In section 2.2 have been estimated the parameters of two rate functions (Briére & Logan) for *L. botrana*, pointing out the respective better working range. In the simulation process, a filter for input daily temperature is included: its task is to work out the daily rate with Briére function if T is between 6.6 °C and 17 °C, and with Logan function if T is between 17.1 °C and 33.9 °C. Outside the range $[6.6, 33.9]\ °C$ the rate is considered to be zero. The results from the simulation process is a 3D plot, which provide the pest insects population trend. This software could provide a decision support system for technicians involved in L. botrana and R. ferrugineus control, but to date is in course of validation. Further works will report a complete description of the results about this operation. Preliminary works are carried out by Severini et al. (Severini et al., 2005) concerning the case of L. botrana in Castelli Romani's area, using the

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Manetsch's Distributed Delay Model. Future goals regard the repetition of the simulation process with this new developed software, and the validation for R. ferrugineus through a monitoring network in the Metropolitan area of Rome.

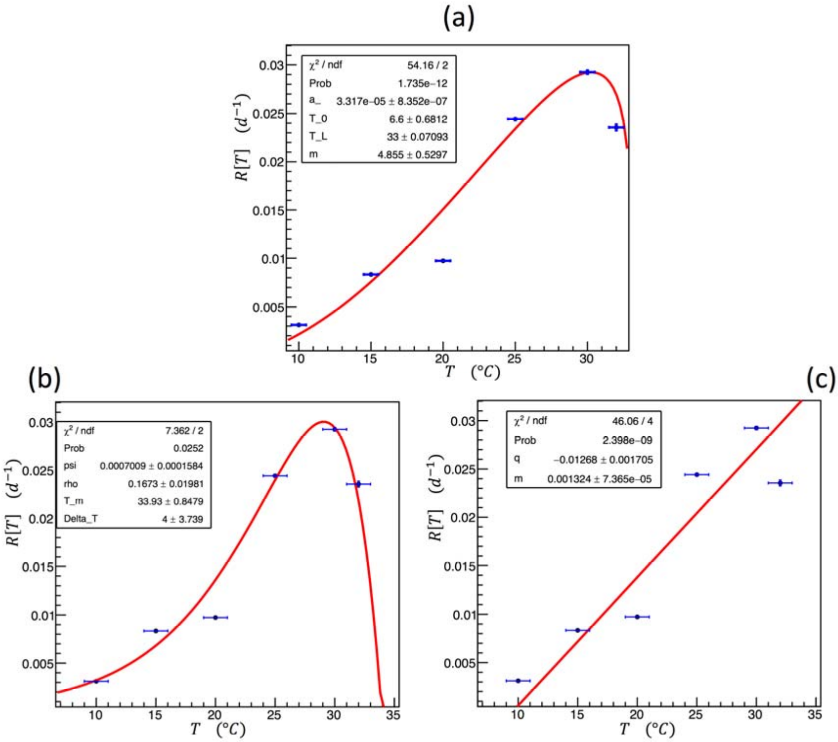

Fig. 1 Graphical fit results from fittasso.c macro with data related to *L. botrana* (Moshtaghi Maleki et al., 2016). The best fit parameters are reported in Tab. 1. (a) is the Briére rate function, (b) is the Logan rate function and (c) is the linear fit function

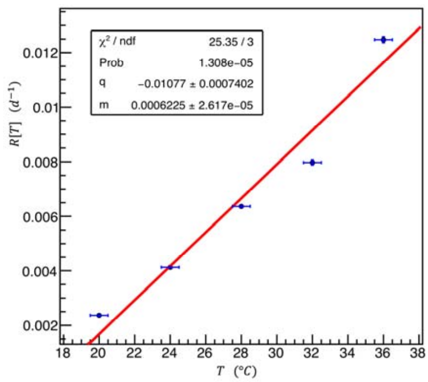

Fig. 2 Graphical fit results from fittasso.c macro with data related to *R. ferrugineus* (Li et al., 2010). The available data have permitted only the linear fitting operation

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4 CONCLUSIONS

In this work, has been presented a new proposal of application of mathematical models to forecast insect's lifecycle not only in an agricultural contest, but also in the case of urban parks and gardens. An ideal operating platform should be consisting of a network of meteorological stations which transmit the temperature in real time to a central unit. This central unit will work out parallel models based on the generalized Von Foerster equation, through the use of macros based on ROOT's libraries. These platforms, could, furthermore, include different species to control: as shown in section 2.2, the kernel of the model is the role of the rate functions. After a good estimation for best fit parameters, the model need only to be run and validate with field monitoring. To have a clear idea of the pest insects' situation in parks and gardens could reduce conspicuously the pesticides treatments, saving the citizen's and environmental health (Speranza, 2008). In addition, several studies in entomology regards the research of parasitoids for the most damaging species, useful to be included in further mathematical models in order to act biological control programs. The extension of this studies in pest insects of urban interest, provide new tools for technicians and agronomists. Nevertheless, a parasitoid could work efficiently only when the host population is not yet high. Simulations can provide this crucial information.

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SPATIAL RELATIONS IN THE BENEFITS FROM ECOSYSTEM SERVICES

THE CASE STUDY OF BRATSIGOVO MUNICIPALITY

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ABSTRACT

The parallel consideration of the urban-rural gradient and center-periphery concepts is useful in the study of ecosystem services provision which is bound to spatial relations. The paper demonstrates an array of factors that have led to certain distortion of the 'ideal' hexagonal network of central places in a broader region including Bratsigovo municipality. The position of the municipality is traced among the definition of central (functional) urban areas, intermediate and peripheral (dysfunctional) rural areas. The classification of the landscape in the municipality and the pertaining of the area to broader socio-ecological systems are identified. The unique position of Bratsigovo and its rich landscape variety are revealed. The paper looks further into the role of local communities, socio-spatial networks and power asymmetries in the patterns of exploitation and appropriation of production, abandonment and stewardship of land and the real benefits from ecosystem services. The case study shows significant mismatches that lead more generally to low urban-rural integration in the region and the externalization of ecological footprint and debt.

KEYWORDS

Spatial Planning; Ecosystem Services; Center-Periphery; Landscape

1 INTRODUCTION

The favorable opportunities offered by the regional view of socio-ecological systems are demonstrated by some reviews of ecosystem services mapping studies (Crossman et al., 2013). Their regional spatial manifestation is revealed through the relations of territories producing or delivering, and territories utilizing or benefitting from relevant services. They may coincide or overlap, be multidirectional from a given position, and have a certain narrow focus on space to adjacent or relatively close areas (Fisher et al., 2008). In addition, it can be said that the landscape is the preferred subject of ecosystem services (ES) research and application (Müller et al., 2010).

The role of the public ecosystem benefits (PEBs) resulting from available ecosystem services for the equity in development can vary greatly depending on the access and control of the biocenose. The different frameworks for understanding ecosystem services relations, their potential value and the impact of their valuation have a more direct or more general attitude towards poverty alleviation (Fisher et al., 2014; Lele, 2013). Particular attention should be paid to criticisms of monetary valuation approaches to the benefits of ecosystems, their commodification and trading with them, through payments to the ES. They are related both to fairness in the distribution of benefits and control power, and to subjective, misleading or too generalized assumptions about valuation (Lele, 2013). However, attempts to map and assess ESs (Lai, 2016) and to evaluate PEBs provide a good basis for debate and for changes in policies and practices. That base includes: (a) the uses of land, their regulation and incentivisation; (b) the appropriate forms of organization, planning and control; (c) the relationship between the supplier and user territories and their intermediaries; d) the long term genesis of the landscape from "pillar" landscapes to transitional ones (Vizzari et al., 2016). The paper makes an attempt for overview of the factors behind the position and conditions of the territory of Bratsigovo with a focus on the ecosystem services and the benefits from them in the centre-periphery nexus and along the urban-rural gradient. The municipality of Bratsigovo is chosen due to its intermediate position and landscape variety in a relatively small area which can be further compared and more deeply analyzed through the proposed conceptual framework, applied methods and results discussed.

2 THE CASE STUDY

The relevance of the ecosystem services concept to Bulgaria and its social-ecological resilience as well as the longer term aspiration for its sustainability is very high. It is due to the observation that in none of the periods in the last century the country achieved favorable levels of resilience and the acquisition of immune power at the societal and the community levels to overcome the crises and to prevent the sudden transitions to qualitatively new conditions (Burov, 2015). This led to both dramatic changes in the landscape and to significant changes in the relationship between society and the natural environment with long-term adverse effects about which plenty of evidence can be found on comparative basis. Bratsigovo municipality (area of 229.425 km² and population of 9648 according to the National Census 2011 distributed in 7 settlements) is located at the eastern border of Pazardzhik district (EU NUTS 3) and in proximity to the center of the South Central region (EU NUTS 2) – Plovdiv. It is at the edge between the Upper Thracian plain and the Rhodope Mountains including lowlands, river valleys, hilly areas, slopes, terraces and ridges with varying geomorphology and hydrology. The climate is humid subtropical and humid continental with vertical variations in temperature and humidity including the rain shadow and aridity northwards from the Rhodope Mountains slopes. The soils diversity and the geological and climatic conditions predetermined the abundance of various habitats and

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species diversity in the area and today bigger part of the municipal territory is covered by the Natura 2000 network. The both flat land and the mountainous landscape in that part of the country has been significantly modified from ancient times onwards with varying patterns of the settlement network in terms of its horizontal density but also its vertical distribution and size of the settlements. The relevant appropriation of the primary production peaked in the mid-20th century when the country as a whole had to be more self-sufficient in terms of food and fibre. Besides the fact that the municipality experienced the benefits from cultural and industrial care and transfer of resources from the Socialist state the area didn't gain much during that time in terms of infrastructure development even though for instance one of the biggest hydro-electrical cascades Vacha in Bulgaria bypasses it. The major communication corridors (e.g. major railways, roads, gas pipes and telecommunication cables) were laid more to the north in the Upper Thracian plain and attract major part of the regional economic activity in the last half a century.

3 THE CONCEPT

The paper's concept tries to unveil how the parallel consideration of the urban-rural gradient and center-periphery ideas is useful in the study of ecosystem services provision which is bound to spatial relations. Those spatial relations are complex and social-ecological in character which means also political in terms of social-economic development and ecological and environmental policies.

Fig. 1 outlines abstract model of regional relationships that can be considered for the specific situation of different regions.

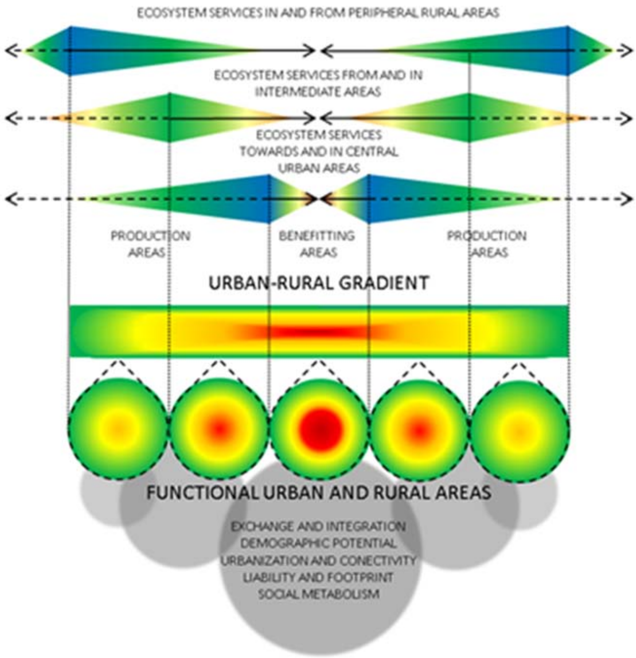

Fig. 1 Urban-rural gradient and functional urban and rural areas with their footprints

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The ecosystem services are presented as follows:

- blue-green – regulating;
- light green and light yellow – provisional;
- orange-brown – cultural.

The urban-rural gradient and the functional urban and rural regions are presented as:

- red – urbanized land cover (structure and functions);
- orange, yellow and light green – agricultural and forestry land cover (structure and functions);
- dark green – natural land cover (structure and functions).

The almost full spectrum colored ecosystem services at the top of the graphic represent the internal and external spatial relations in the production, distribution and benefits from the ecosystem services in regard to general stocks and flows from and towards the peripheral, intermediate and central areas. In that regard it is important to underline the importance of peripheral and intermediate rural areas as ecosystem services providers in the full range of regulating, provisional and cultural ones. Often, they provide such services not only to the adjacent city centers and populations but also to other territories and globally to commons such as the atmosphere and especially the climate regulation. This can enable better shaping of policies and the design of their sophisticated application in rural areas. Certainly there is extraction of resources from the rural areas and the benefits usually go mostly to the centers through the unequal exchange on regional, national and global level. The initial historic regional integration is disrupted due to the shifting demographic potential from the local to the global levels leading to changing patterns of urbanization and connectivity. It is a fact that many countries provide financial and other transfers to rural areas but not from the ecological liability and footprint perspective (represented in gray on the graphic) and through the holistic consideration of the social metabolism process. That process constitutes not only of the material and energy flows but also includes the varying benefits for the extractors, producers, distributors, intermediaries and consumers along the commodity chains.

4 THE METHODS APPLIED

In the attempt to describe the centrality nodes and axes pattern, the triangular-hexagonal network model is used as a framework. The model has the appearance of a honeycomb as it was developed in the "central place theory" (Christaller, 1933). The experience here abstains from the distances proposed as basic to the original model, taking into account the profound criticism of many of its assumptions (Nicolas, 2009). The comparison of the model with the contemporary settlement network is based on georeferencing of the raster network through the 33 points from the first to the fifth rank. A Thin Plate Spline transformation with the Nearest Neighbor resampling method in the environment of Quantum GIS 2.0.1-Dufour was used.

In the attempt to define the peripherality of the individual and the groups of peripheral settlements and their land areas the following seven overlapping criteria for time cost in space are used: 1) over 90 min from a city with a population of over 500 000 inhabitants; 2) over 60 min from a city with a population of over 200,000; 3) over 45 min from a city with a population of over 100,000; 4) over 30 minutes from a city with a population of over 50,000; 5) over 15 minutes from the city (district center, agglomeration) with population over 20,000; 6) over 10 min from a town (agglomeration) with a population of over 10,000; 7) over 5 minutes and is not a city (municipal center) with a population of over 5,000. Those time costs are investigated on the basis of working points representing the time thresholds along the road network and travel time estimations in Google

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Maps. Those thresholds were decisive for the definition of every settlement and its land area into the category peripheral or not.

In the attempt to visualize the demographic potential a heatmap is prepared based on the data for the population in every settlement of the South Central region. A 25 kilometer radius was used, allowing the aggregation of the areas with more or less significant demographic potential.

The final attempt is the definition of the socio-ecological systems and subsystems borders into which Bratsigovo municipality is part or which are part of it. They provide an idea about some physical, chemical and biological, ecological and social factors which determine relations in and between the social and the ecological processes. In addition to this there is literature reviewed about the contemporary landscape classification and the valuation of the ecosystem services in the municipality.

The general approach in the assembling of the different methods of analysis is qualitative and it is part of the discussion.

5 THE RESULTS

The exemplar study includes Bratsigovo municipality and Bratsigovo town as part of the settlement network of the South Central region in Bulgaria and beyond the country borders. Fig. 2 shows the assumptions about the location of the central places (urban centers) in the hierarchical order outlined in the hexagonal model.

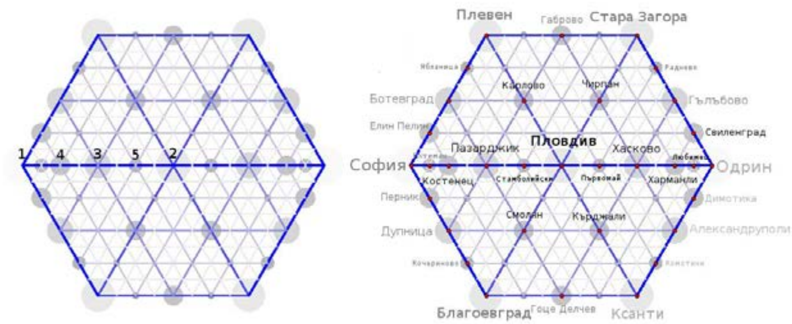

Fig. 2 Hexagonal network model and assumptions about the central places

The resulting image after the application of the Thin Plate Spline georeferencing (Fig. 3) demonstrates the distortion of the 'ideal' hexagonal network of the assumed central places. In the specific case of the region, the Sofia-Edirne(Odrin)-Istanbul axis was chosen as the main setting, which is a permanent axis of historical and current development.

The position of Bratsigovo in the graphic shows contraction of the triangle overlaying the northern part of the municipality and the contrary for the triangle over the southern part of it. This represents the fact that the northern area of the municipality is in proximity to other neighboring urban centers and much better connected to the region.

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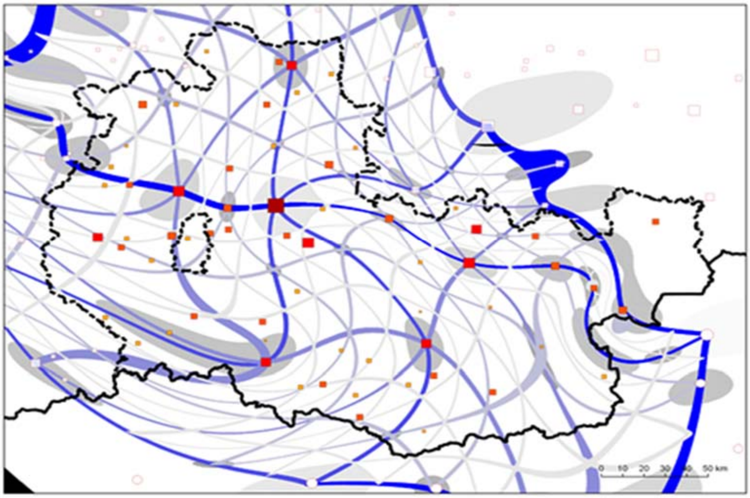

Fig. 3 Overlaying the hexagonal networking model and the contemporary network of central places

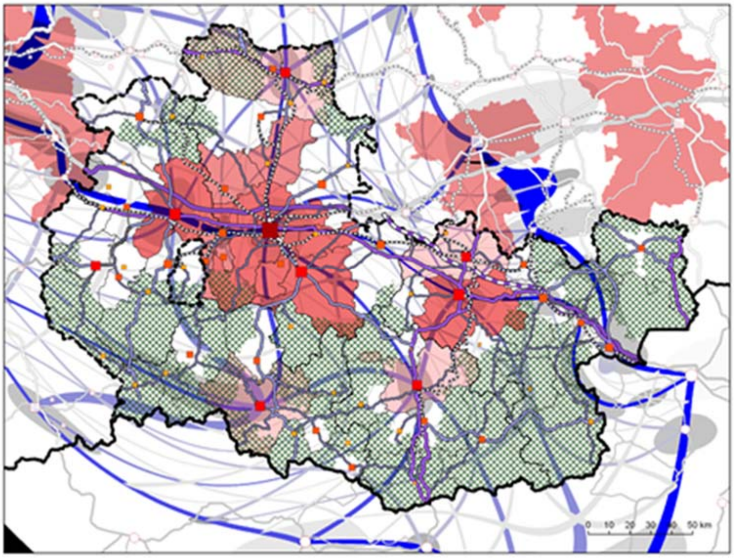

Fig. 4 Extents of the central urban areas (central municipalities (NCRD, 2012) with diagonal X red hatch; functional urban areas (EC, 2016) with solid red hatch) and the peripheral rural areas in the South Central region and the distorted hexagonal settlement network

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The southern area is part of the Rhodope Mountains which is very isolated due to steep slopes, high altitude climate and less agricultural opportunities, low density of infrastructure but also previous state borders at the end of the 19th and the beginning of the 20th century.
The application of the criteria for peripherality of the land areas of the settlements (Fig. 4) is compared to the extents of the nationally defined central municipalities in the National Concept for Spatial Development (NCRD, 2012) as well as to the boundaries of the functional urban areas (FUA) with urban centers of at least 50000 residents from the Urban Atlas (EC, 2016). The map shows as well the availability or lack of relevant road or rail connections along the distorted 'ideal' web of axes linking the separate nodes.
The influence of the polycentric criteria for determination of peripherality is obvious. The municipality of Bratsigovo is intermediate rural area being at the edge of more central functional urban areas and part of it can be described as peripheral rural area – that is the high altitude village of Ravnogor.
Further on an aggregated interpretation of the demographic potential, urbanization and connectivity is made (Fig. 5) through the heat map based on the location of the population, the major urban centers and the communication infrastructure in the South Central region. It synthesizes well the regional (dis)integration of the whole territory and also the variable demographic potential in the territory of Bratsigovo municipality.

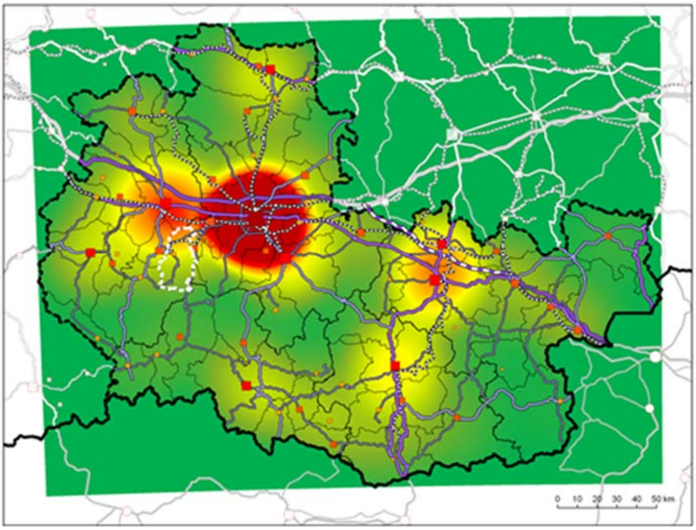

Fig. 5 Aggregation of the demographic potential along with the urban centers and the connectivity infrastructure

Finally the extents of meso and micro socio-ecological systems are compared to the range of different administrative units at regional and local level with regard to Bratsigovo municipality (Fig. 6). The following socio-ecological systems are illustrated:

- Batashka mountain and Besaparski hills in the massif of the Rhodope Mountains;
- the surface basin of the Stara Reka, its tributaries and tributaries of the river Vacha in the Maritsa river basin;
- the municipalities and districts in the South Central Region.

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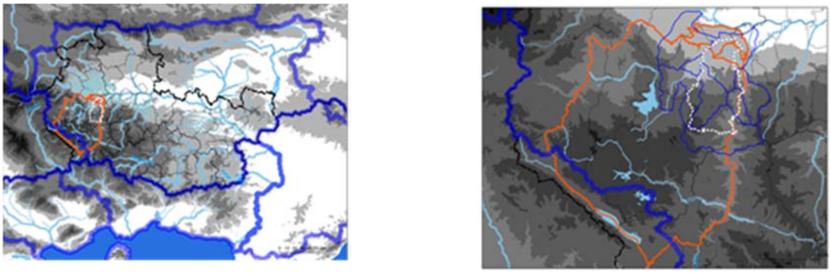

Fig. 6 Extents of socio-ecological systems and administrative units: geological systems (orange), river basins (blue)

The landscape classification and the ecosystem services are initially well described by two separate studies from the 'Rhodope Project' ('Preservation of the Globally Significant Biodiversity in the Landscape of the Rhodope Mountains'). A map of contemporary landscapes on a scale of 1:75 000 has been prepared thanks to the so called 'Rhodope Project' as part of the publication Atlas of the Contemporary Landscapes of the Rhodopes (Gikov & Nedkov, 2008). Most of the variety found in the Rhodope Mountains which is considered hot spot for biological and landscape diversity in Europe is found also on the territory of Bratsigovo municipality. Natural, slightly and moderately modified landscapes dominate the contemporary landscape, which is typical for the intermediate areas along the urban-rural gradient. Another contribution of the 'Rhodope Project' is the review of ecosystem services and benefits in the Rhodope municipalities which outlines the following characteristics for Bratsigovo municipality (Zervudakis et al., 2007). That initial assessment gives an overall orientation on the high value of ecosystems in the municipality of Bratsigovo. The need for further studies, both at national, regional, and local level, is linked to the many methodological issues of assessment and valuation, which often involve more general assumptions and arbitrary values. Nevertheless these two studies from the 'Rhodope Project' reveal well the unique position of Bratsigovo and its rich landscape variety. Yet, the contemporary conditions of Bratsigovo municipality in social-ecological terms can be described through these characteristics (OUPO Bratsigovo, 2035, 2017):

- aging and shrinking especially in the upper altitude settlements;
- seasonally intensive visitation by second home owners;
- architectural heritage loss and new greenfield urbanization in parallel;
- less economic activity and entrepreneurship with decaying industrial sites from the Socialist past;
- agricultural (arable and pasture) land abandonment in the medium and higher altitude belts;
- ecological succession over the longer term abandoned land;
- intensive and sometimes illegal lodging at certain spots even in protected natural areas.

6 DISCUSSION

The long term possibilities for multifunctional land stewardship or the added value of clusters that need a more integrated and holistic way of thinking are hardly achievable due to the missing culture of collaboration and cooperation which are rear and almost extinct in the municipality.

The local communities are more importing than exporting in terms of goods and services with the typical for rural areas help of the national transfers for pensions of the retired. Local entrepreneurship is not enough to

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enforce the endogenous development on the basis of the various and rich local resources. Certainly aging is the main constraint with the addition that local elites have occupied key assets around which there is stagnation or deadlock going on. The involvement of politically powerful age stratified groups does not allow the easy entrance of new independent actors either internally or externally.

Thus a big amount of the biocapacity of the municipality is not being utilized. Even though the population is shrinking the community goes into ecological debt due to diminishing levels of subsistence or semi-subsistence agriculture. The few farms are oriented less towards the local and regional market and prolonged distribution of primary goods can be observed.

All these strokes try to briefly describe the significant mismatch that leads more generally to low local and regional integration. There is high demand for the establishment of regional socio-spatial networks organized around market relations and demand, development frameworks and promotion approaches, conservation projects and protection activities, emotional attachment and search for new experiences, solidarity ventures and transition for the improved integration of the rural areas and the urban centers.

7 CONCLUSION

Here rests the conclusion that internal regional integration is likely to shorten links, internalize the footprint and contribute to the circular metabolism of a region. All this can be in parallel to the preservation and development of the levels of external connectivity and exchange within the thresholds of reproduction of renewable resources. It can happen through the creation of prerequisites for network and local initiatives based on contextualized research and innovation.

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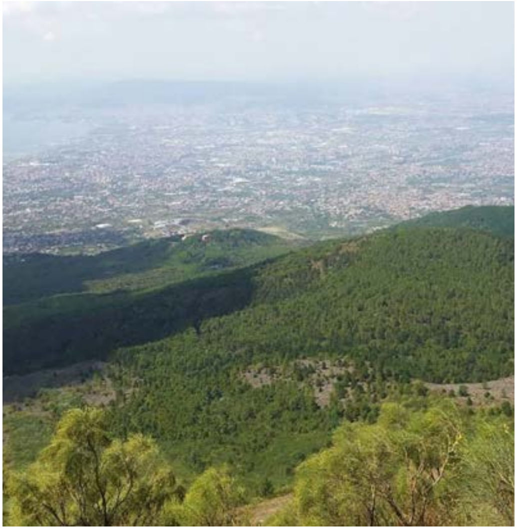

HISTORICAL LAND USE CHANGE AND LANDSCAPE PATTERN EVOLUTION STUDY

A SUPPORT OF LANDSCAPE DEVELOPMENT POLICIES IN VESUVIO NATIONAL PARK

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ABSTRACT

Historical land use change studies and modelling support the analysis of current land use dynamics and landscape pattern. Historical maps are sources of geographical information and traditionally landscape uses, once geo-referencing accuracy and information reliability have been verified. GIS processing and landscape metrics allow assessing and deepening the land use changes. Vesuvius and surrounding areas are an important Italian landscape, full of historical, geo-morphologic and naturalistic value, with valuable agri-food productions and with very-high population density. Furthermore, the area has a high quality historical cartographic production. The main purpose of the paper is to deepen historical landscape knowledge, from 1817 up to 2009, and to implement the historical analysis framework. Historical cartographies of different time steps (1817, 1875, 1960) were digitized, georeferenced and manually vectorized for map comparison, by means of ArcGIS tools and Kappa statistic algorithms. Finally, landscape pattern changes were calculated through Fragstat metrics. Considering the overall period, only the 50% of the study area did not change: major changes were registered in vineyards and urban areas (-99.6% and +89%, respectively). Landscape mosaics appear more disaggregated (PLADJ and DIVISION metrics) due to different number of patches and their more irregular shape (NP, DP, LSI metrics). The study shows the utility of integrated approaches and tools, starting from historical cartography opportunities, as support for decision maker in land use management and conservation policies, highlighting interrelations between urban, agricultural and natural areas.

KEYWORDS

Land Use Change; Landscape Metrics; Historical Cartography; Geographic Information System (GIS)

1 INTRODUCTION

Land use changes (LUCs) study, as historical analysis and prediction, allows better understanding the current conformation of a landscape system, recognizing the complex system of dynamics and driving forces operating, monitoring the developmental dynamics, verifying the adopted policies, to construct future scenarios, evaluating their possible environmental and socio-economic impacts, supporting the landscape management and planning with a view to sustainability. LUC analysis supports the site-condition assessment in order to understand the landscape potentials and to plan landscape resources toward more sustainable uses. Within the historical LUCs, historical maps are effective sources of geographical information, useful for historical and territorial research (Pindozzi et a., 2016). The historical maps availability, in chronologically succession, makes it possible the multi-temporal analyses about the landscape morphology and pattern, useful in landscape planning (Bibitelli & Gatta, 2013). Specifically, the historical LUC analysis, with the support of GIS technologies, allows highlighting not only where changes occurred and what changed, in terms of areas variations inside the different land use classes, but also the structure and configuration of these variations.
In this point of view, Landscape metrics (LMs) are useful tools, being algorithms that quantify spatial characteristics of patches, classes of patches or entire landscape mosaics and helping mathematically assessment of landscape structure, giving valuable information to improve the assessment of the ecological functioning, economic wealth and aesthetic value of a region (Gustafson, 1998; McGarigal et al., 2002; Uuemaa et al., 2009; Frank et al., 2012; Lausch et al., 2015).
In European context, the Vesuvian areas, as all the rest of Neapolitan areas, has developed a high quality cartographic production starting from the end of the seventeenth century; The study area is moreover characterized by high cultural, historical, geo-morphologic and naturalistic values, with also a food-agricultural production unique for originality of flavours variety and with very-high population density. Therefore, Vesuvian area becomes a useful reference for historical cartography in-depth analysis and for land use and land cover dynamics analysis.
The aim of the paper is to support land-use planning in a context that, besides the presence of natural protected areas and one of the most known and potentially dangerous volcanoes in the world, presents also a strong anthropization, as result of a secular process, and close relationship between urban, agricultural and natural components.
The framework entails a phase of importing and GIS digitalization of historical cartographies; a phase of analyzing and comparison among the LU maps, in terms of areas and land use classes; a phase of assessment of landscape configuration and composition.

2 MATHERIALS AND METHODS

2.1 STUDY AREA

The study area entails the total extension of 13 Municipalities falling within the perimeter of the Vesuvius National Park, with the exception of areas not covered by available historical data and cartography. This perimeter, exceeding the limits of the natural park, makes it possible to carry out assessments on the dynamics among the natural, rural and anthropic components, allowing the mutual comparison and evaluation of spatial relationships, which have generated the current landscape pattern.

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In addition, the need of geo-referencing maps, basing on territorial invariants (buildings or roads networks), conditioned the definition of the study area perimeter including also artificial surfaces.

The final study area extends, therefore, on about 16800 ha (Fig. 1). It includes the still active volcanic complex "Somma-Vesuvio", the most important in continental Europe. The resident population involves about 350000 inhabitants (census data 2017), recording a moderate negative trend starting from 2013. To underline the strong anthropic pressure, study area is included in Naples metropolitan areas that presents about 3,5 M of inhabitants.

Vesuvius National Park was instituted since 1995 (by means of DPR 5/06/1995), starting from the Italian national law n° 394/1991. Within the boundaries of study area there are also: a state reserve, two Sites of Community Importance (SCIs) and one Special Protection Area (SPA). Typical agricultural products are underlined by quality and geographical indication certifications, i.e. for wine, apricots, tomatoes and cherries.

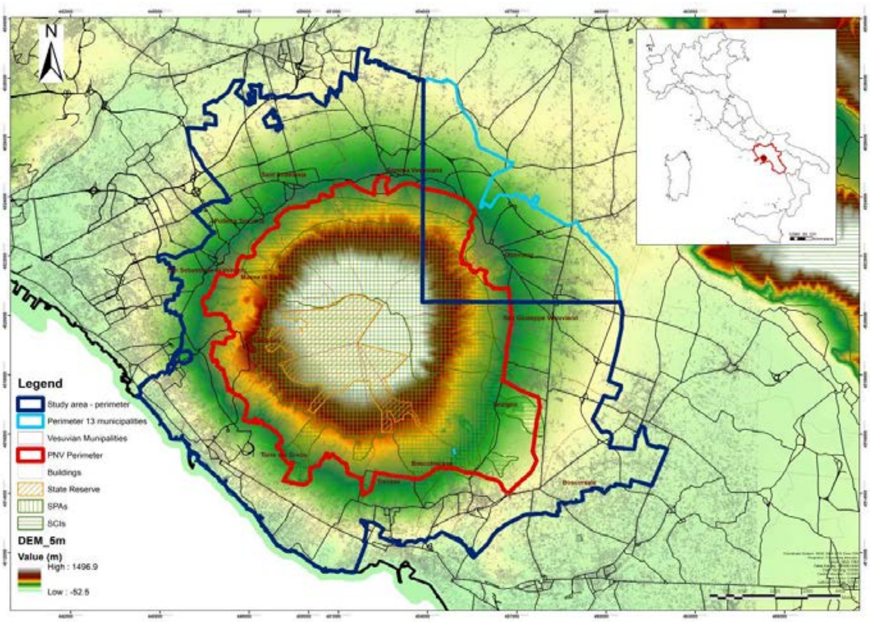

Fig. 1 Study area (Source: our elaboration, 2018)

2.2 HISTORICAL MAPS AND RECENT DATASET

In order to classify and analyze land use/land cover changes (LUCCs) during the last two centuries, a multi-temporal dataset has been used:

- 1817 - Topographic and hydrographic contour map of Naples edited by "Regia Officina Topografica di Napoli" (Royal Topographic Office) - sheets numbers 9 and 12 - 1:25 000;
- 1907 - Topographic map of Italy Edited by "Istituto Geografico Militare Italiano" (Italian Military Geographic Institute) 25v series – Sheets numbers F. 184 I S.E. (Pomigliano d'Arco), F. 184 II N.E. (Monte Vesuvio), F. 185 III N.O. (Boscotrecase) - 1:25 000;

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- 1960 - Land-Use Map of Italy Edited by Touring Club Italiano/ "Centro Nazionale Ricerche" (Italian Touring Club/National Research Center) - 1:200.000 (CNR and Touring Club Italiano)
- 2009 - Land-Use Map of Campania region – 1:100.000 (Campania region, Ass. Agricoltura Settore SIRCA)

As a support for the geo-referencing process of historical maps, the Regional Technical Map (CTR) 2004-2005, scale 1:5000, has also been used. Historical maps need important pre-processing steps, before their analysis in GIS environment. In primis a digitization step is needed to import paper information into digital support. A scanner with 300dpi resolution was used and all cartography papers were converted in TIFF files. Then, images imported have been georeferred in a common coordinate system, to allow spatial analyst processing (Brovelli & Minghini, 2012).

The Ground Control Points Method (GCP Method) was adopted, which establishes a mathematical/statistical relationship between the pixels coordinates on the raster and those of reference (UTM-WGS84, 33N). The number of GCP depends on the transformation order to be used and on the precision to be obtained. A first order polynomial was generally used for the transformations. The accuracy was verified through an "inverse" mapping function, which calculates the globally quadratic error and the accuracy of each GCP. The quality of the georeferencing process was evaluated by overlapping the historical cartography with the current Regional Technical Map (CTR ed. 2004-2005) of Campania region with a scale of 1:5000. After georeferencing process, all historical maps were composed together by mean of Mosaic tool in ArcGIS, obtaining a unique raster file for each dataset.

2.3 DATASET ANALYSIS AND LAND USE CHANGE COMPARISON

To improve analysis of the landscape relationship (namely: connections, intersections, adjacencies, inclusions, etc.) between objects or patches, a vectorialization process, consisting in a manual conversion from raster to vector, was performed. Entities are visually recognized and reconstructed directly on the raster image, operating in a GIS environment. To mitigate eventual errors due to operator, a following post-processing phase, devoted to the final inspection of the vector file created, has been carried out. Manual vectorialization was performed by means of code of polygons associated to defined land use/land cover classes.

The subsequent multi-time comparison between pairs of land use maps was conducted after a thematic generalization to have a common land use/cover classification for each reference year. The classes considered were the following: Agricultural uses, Vineyards, Urban, Sparse vegetation, Forests.

In order to not lose information on the vineyards (which have been reported with a very clear symbology already from the cartography of 1817), this class has been kept separate from other agricultural uses. Overall, difficulties have been found due to folds, stains and lacerations, present in the analogical cartography.

Once the historical maps were converted into vector file (polygon) (Fig. 2), by interpreting phase, the comparison was made by means of Map Comparison Kit (MCK) open source software, developed by Institute of Research for Knowledge systems (RISK) in Maastricht, Netherlands. All new thematic maps were converted in raster, cell size 20x20m, and then in raster-ASCII, in order to import them into MCK software. In the present work, two algorithms belonging to MCK software have been used for the LUCC analysis: by category and Kappa statistic. The category algorithm splits information from the global context to focus on each category: the result is to be considered a partial expression of the cell by cell comparison applied to a single category (Caglioni & Rabino, 2008).

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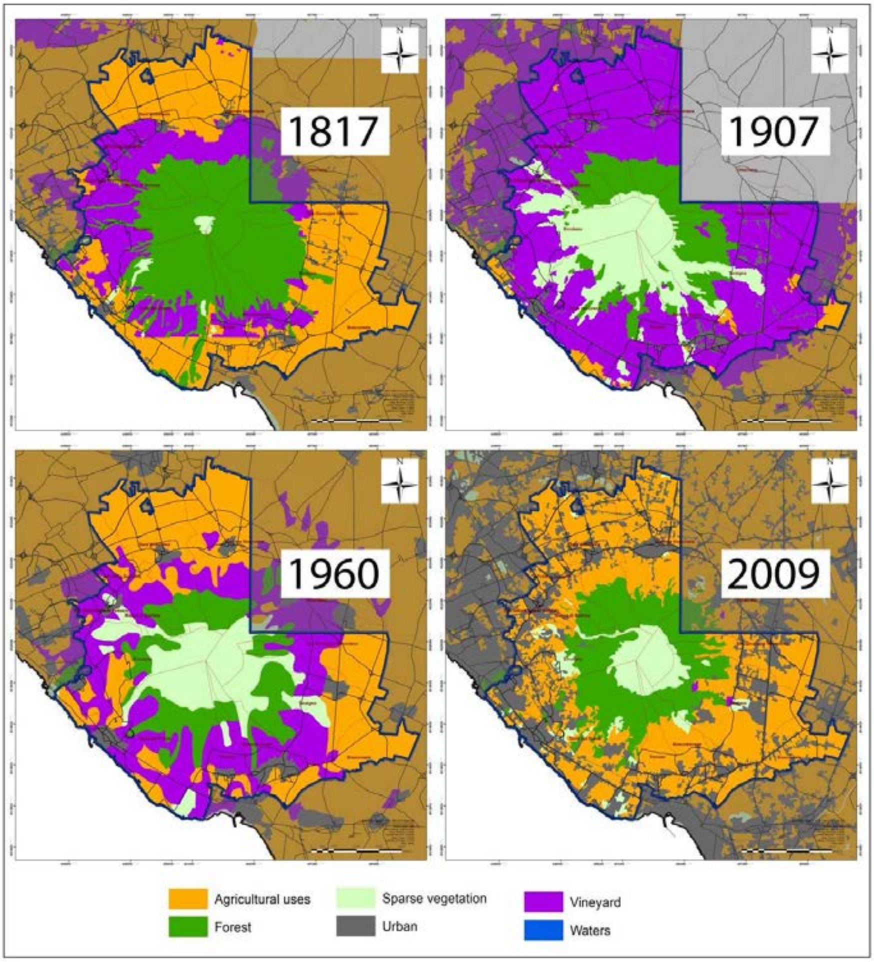

Fig. 2 Time series of land cover maps from 1817 to 2009 (Source: our elaboration, 2018)

Kappa statistic synthesizes information about location (spatial correlation) and about the amount of cells for each category (RIKS, 2018, http://www.riks.nl/news). The Kappa statistic algorithm, also based on the cell by cell comparison, expresses the degree of agreement between two categories of datasets. Kappa is the result of the product between two similarities: the quantitative similarity (Kappa Histo or K_{Histo}) and the spatial similarity (Kappa Location or K_{Loc}).

The quantity refers to the total number of cells for each LU class (the histogram), regardless of spatial allocation, while the position similarity refers to the spatial distribution of the different LU classes on the map, regardless of the total number of cells for category (Visser & de Nijs, 2006). Kappa, as well as K_{Loc} and K_{Histo} are calculated on the basis of the 'transformation matrix', which reports the cross-distribution of the categories

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on the two maps. The coefficient of agreement kappa can assume values between - 1 and 1. The more kappa is closed to 1 the more the correspondence is good.
On the other hand if K<0, there is no correspondence; the contingency matrix was built according to a standard procedure (Pindozzi et al., 2016).
The comparison was made on the maps of the land uses thus associated: LU 1817 and LU 1907, LU 1907 and LU 1960, LU 1960 and LU 2009 and, finally, over the whole period going from 1817 up to 2009.

2.4 LANDSCAPE METRICS

Land use and land cover change determines landscape patterns and affects the ability of ecosystems to provide the services and biodiversity on which humans ultimately depend: LUCC, as result of new policies and human activities, can modify the original structural integrity of landscape, with cost (to avoid) or benefits (to facilitate) the ecological flows.
Landscape metrics (LMs) can help understanding and analyzing these changes, providing valuable information to improve the assessment of ecological functioning, economic wealth and aesthetic value of a region.
In this paper, LMs was used to analyze the eventually fragmentation of landscape patterns in the various historical steps studied. Specifically, in landscape level metrics, the “Aggregation” metrics were considered. These metrics refer to the tendency of patch types to be spatially aggregated. This property is also often referred to as landscape texture, and it is, usually, used as an umbrella term to describe several closely related concepts of dispersion and interspersion, subdivision, and isolation.
Specifically, we referred to: Number of Patches (NP), Patch Density (PD), Aggregation Index (AI), Percentage of Like Adjacencies (PLADJ), Patch Cohesion Index (COHESION), Landscape Shape Index (LSI), Landscape Division Index (DIVISION).
Four LU/LC vector maps, arising from ArcGIS interpreting phase, were converted into 4 raster image, in order to run Fragstat software; cell size defined is 1x1m, less then ½ the narrowest dimension of the smallest patches. Input grids consist in square cell, with metric projection (ETRS89, UTM 33N).
Starting from raster LU/LC maps, the LMs were quantified by means of Fragstat software, defining 8 cell neighbourhood role and class metric as sampling strategy.

3 RESULTS

About georeferencing process of historical maps, to get attainable results, GCPs were selected firstly in the urban centers where easily identifiable persistent elements there were. All maps were georeferenced through first order polynomial transformation. The RMS was in the order of tens of meters, and this has allowed a satisfactory level of processing accuracy to be achieved.
About land use change comparison, the results were organized comparing a pairs of subsequent maps: 1817-1907; 1907-1960; 1960-2009 and 1817-2009. In 1817, agricultural uses affect more than half (43%) of the total area, if also the vineyards are accounted in the agricultural areas, this percentage increases up to 64%. In the period 1817-1907, the 51% of total area changes, especially due to changes of vineyards and urban surfaces.
In the period 1907-1960 the countertrend from vineyards to other agricultural uses was the main characteristic. In the period 1690-2009 it is possible to observe a strong reduction of agricultural lands caused by the markedly expansion of urban areas. Finally, Tab. 1 shows the results of comparison for whole period 1817-2009: about the 51% of the total area change in land uses, during the last two centuries. Main changes

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concern the "vineyards" which are quite all disappeared within the study area, and the "urban" areas, that have increased their size tenfold.

MAP 1817 \ MAP 2009 (hectares)	AGRICULTURAL USES	VINEYARDS	URBAN	SPARSELY VEGETATED	FORESTS	SUM MAP 1 (1817)
Agricultural uses	48463.2	0	22668	818.4	262	72211.6
Vineyards	21720.4	0	9340	1697.6	1984.8	34742.8
Urban	709.2	0	4418.4	74.8	100.4	5302.8
Sparsely vegetated	335.6	0	562.8	596.8	291.6	1786.8
Forests	9876	243.6	3988.8	10387.6	29715.2	54211.2
Sum Map 2 (2009)	81104.4	243.6	40978	13575.2	32354	168255.2

Tab. 1 Land use change comparison: Transformation matrix (period 1817-2009) (Source: our elaboration, 2018)

About landscape metrics, the NP metric shows the doubling of the number of patches over two centuries (from 171 to 381) as confirmed also by the PD metric (from 1.02 to 2.26). The LSI metric underlines how the patches perimeter is currently more indented than in 1817: also in this case the value is doubled (from 10.68 to 20.40). Finally, PLADJ, COHESION, DIVISION and AI metrics show a more disaggregated landscape than 1817.

4 DISCUSSIONS AND CONCLUSIONS

The present work has highlighted how the availability of historical cartographic documentation (with high geodesic accuracy) and its integration in geographical information systems (GIS) can support multi-temporal analyses of landscape (Campana, 2003). The quality and reliability of the historical cartography used (Visconti 1817, IGM 1907) was confirmed by the overlapping of the georeferenced maps with the CTR of the Campania Region. A weakness of geodesic historical mapping is the lack of a greater detail in LU classes (for example in the agricultural use class it was not possible to distinguish between the arable land or the vegetable garden or other).

The only exception is the vineyards, whose very clear symbology starting from the cartography of 1817, has allowed separating the relative class from other agricultural uses. The comparison analysis of thematic LU/LC maps showed that about 50% of the Vesuvian landscape has been affected by LUC during the last two hundred years. The awareness of favorable environmental conditions (the climate and the volcanic nature of the land) and of traditions and quality certifications, could have supported the permanence, in the study area, of the vineyards, today almost totally substituted by other agricultural uses. Further observations can be made regarding the urban and artificial areas growth (+80% from 1960 to 2009, about 24% of total area in 2009 against the 3% in 1817 or 4% in 1960), according to the Italian trend, starting from the 1960s and which is not justified by the increase in population in the same period (+ 20%, on a national basis).

The landscape metrics analysis emphasizes a recent pattern certainly more fragmented, compared to the one of two centuries ago. The trends are confirmed in the various time steps examined, with the exception of the Touring Club map (1960), maybe due to the scale of the map, 1: 200.000, which inevitably simplifies the polygons. By integrating the results of landscape fragmentation with LUCs, further investigations will be carried

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out on the class scale and not just on the landscape scale, especially for classes "urban areas" and "forest", in order to highlight reciprocal relations or pressures. The study on the land uses dynamics confirms to be a useful tool to support the land-use planning and management, in terms of verification, monitoring and comparison, but also simulation and projection, of the policies and strategies for sustainable landscape development and for the landscape-environmental heritage management: landscape fragmentation risk, loss of biodiversity, climate changes, hydrogeological instability are the main challenges in which historical land use changes (and their effects) GIS-based study can contribute to implement the knowledge of the land context and to support sustainable strategies.

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LANDSCAPE DEFRAGMENTATION POLICY AND PLANNING

AN ASSESSMENT OF STRENGTHS AND WEAKNESSES

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ABSTRACT

Landscape fragmentation (LF) is one of the main negative effects due to transport and mobility infrastructures and urbanized areas and consists of a dynamic process, where large habitat patches tend to become smaller and more isolated than in their original condition. As for biodiversity conservation, LF affects landscape quality, triggering isolation of population and reducing movement and dispersal of species. So, landscape defragmentation, i.e. the inverse process, where certain actions lead to a re-connection of landscape patches, is of paramount importance in the perspective to achieve healthy landscapes. Typical defragmentation actions include measures for protecting fragile habitats and inserting them in interconnected systems, such as ecological networks and green infrastructures. Landscape policies and planning in Europe are characterized by the implementation of the European Landscape Convention (ELC), which stresses the importance of landscape quality objectives and gives the same importance to all types of -i.e. also rural and degraded- landscapes.
In this study, we aim at building a method for scrutinizing the attitude of policy and planning tools to consider LF and to envision landscape defragmentation actions. The method will be discussed in the light of recent advances of landscape planning theory and practice and tested in selected regional case study.

KEYWORDS

Landscape Fragmentation; Regional Landscape Plans; Landscape Planning

1 INTRODUCTION

In the last decades, scientific literature has shown a growing interest for biodiversity conservation and ecosystem continuity maintenance. The fulfillment of human needs has resulted in an increase of worldwide resource consumption and changes in land use, with negative effects on habitats and considerable biodiversity loss (Foley et al., 2005; Foley et al., 2011). Landscape fragmentation (LF) is closely linked to human activities and can be induced by transport and mobility infrastructures and urbanized areas. According to the European Environment Agency, a series of measures able to address LF should be included in both regional and transport planning (EEA, 2011). At strategic level, measures such as systems of green infrastructure, habitat networks, and defragmentation plans, could be implemented to deal with LF (EEA, 2011). As a first step, measuring LF would be desirable to (1) remark critical geographical areas that need to be defragmented or reconnected, and (2) figure out where new transport and mobility infrastructures or urbanized areas could be built-up. Thus, the regional landscape plan (RLP) appears as a useful tool that could integrate LF measured at landscape unit scale (De Montis et al., 2017; De Montis et al., 2018). In this way, the RLP would provide a LF framework that supports planners (urban planners, transportation planners, etc.), decision-makers and stakeholders, during the planning process at regional or sub-regional level. In this study, we scrutinize four-last generation Italian RLPs to investigate if and to what extent they deal with LF, if fragmentation metrics are suggested and applied, and if defragmentation strategies or measures are planned. The paper unfolds as follows. In the next section, we provide an overview on last generation landscape planning in Italy. In the third section, we report on scientific literature that addresses landscape fragmentation in landscape planning. In the fourth section, we describe the method used in this study to meet our purposes. In the fifth section, we show and discuss the results. Finally, in the last section we illustrate the concluding remarks.

2 LANDSCAPE PLANNING IN ITALY

The European Landscape Convention (ELC), an international treaty that focuses on the protection, management and planning of all European landscapes (Council of Europe, 2000), defines the landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000). The ELC applies to the whole territory and covers natural, rural, peri-urban, and urban areas, including both exceptional and degraded landscapes (Council of Europe, 2000, 2008), giving the same importance to all types of landscapes, which are key elements of European cultural identity (Piorr & Müller, 2009). The importance of rural areas was further underlined in a recent recommendation that aims to promote landscape awareness through education (Council of Europe, 2014).

Landscapes constitute a common resource and are acknowledged as key elements for individual and common well-being, as well as the foundation of local identity. The ELC can be considered as a new tool for the protection, management and planning of all European landscapes, and it is contingent on the following key assumptions (Romani, 2008): (1) landscape is recognized as a public good; (2) landscape exists a priori; (3) landscape is important as a vital context for people; (4) people have a right to landscape. In agreement with the ELC, the landscape dimension should be considered in the drafting of all land management policies in order to achieve best quality in safeguard, management and planning proposals. Every plan or project should comply with the quality objectives of the landscape, improving the landscape quality, or at least not contributing to its deterioration. The possible impact of projects on the landscape, whatever their scale, should therefore be assessed beforehand (Council of Europe, 2008).

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With regards to landscape policies, the ELC requires, inter alia, a new operational approach for the observation and interpretation of landscape, which should: (1) consider the territory as a whole (and not just locate places which need to be protected), (2) simultaneously include and combine several approaches, linking ecological, archaeological, historic, cultural, perceptive, and economic approaches, and (3) take into account social and economic issues (Council of Europe, 2008).

In 2004, Italy introduced the principia and contents of ELC through the Legislative decree no. 42 'Code of cultural heritage and landscape' (the Code; Italian Republic, 2004, 2006, 2008).

According to the Code, the regions must draw up and approve the RLPs so that all the national territory is protected, ensuring that actions on the landscape are planned in agreement with the objectives of landscape protection. The Code sets out purpose and content of the RLPs, which aim to preserve, restore, and enhance elements of the territory representing the national identity. These elements include natural and human factors, and their interrelationships. In accordance with these criteria, also purposes for sustainable territorial development must be covered.

The landscape plan's drawing up process includes: (1) reconnaissance of the planning area, through the analysis of its landscape features; (2) recognition of the properties and declared areas of considerable interest; (3) identification of any additional properties or areas of significant public interest; (4) analysis of spatial dynamics; (5) identification of appropriate actions for restoring degraded areas and other landscape enhancement measures; (6) identification of proper actions on the landscape, in order to achieve sustainable development in the affected areas. The RLPs that were drawn up and approved by the regions before the entry into force of the Code had to be adapted to the content of the Code by December 31, 2009. According to the Code, municipalities, metropolitan cities, and provinces have to adjust their planning instruments to the contents of the RLPs.

The provisions and expectations of the RLPs cover, inter alia, the recovery of landscape values, the recovery of degraded areas, and the identification of urban development strategies, with particular focus on safeguarding of rural landscapes.

3 LANDSCAPE FRAGMENTATION IN LANDSCAPE PLANNING

The LF can be considered as one of the most widespread landscape phenomena in the European context (Llausàs & Nogué, 2012) and consists of a process where habitat patches tend to become smaller and more isolated over time (EEA, 2011). LF is due to natural and human processes. The human action is the most important cause of LF (Harrisson et al., 2012) and includes transport and mobility infrastructures and urbanized areas (De Montis et al., 2017; De Montis et al., 2018). LF has negative effects on biodiversity (Battisti, 2004; Gibson, 2013) and can trigger phenomena such as population decline (Collinge, 1996; Harrisson et al., 2012).

In territorial planning policies the maintenance of ecosystem continuity has become a central element (Romano & Tamburini, 2001) and some policies - such as the Diversity Convention and the Ramsar Convention - have been developed to maintain ecological connectivity (Kettunen et al., 2007).

The ELC aims also to "promote landscape protection, management and planning [and landscape protection means] actions to conserve and maintain the significant or characteristic features of a landscape [...]" (Council of Europe, 2000). According to the ELC, landscape policy is relevant and includes "principles, strategies and guidelines that permit the taking of specific measures aimed at the protection, management and planning of landscapes" (Council of Europe, 2000) expressed by the competent public authorities.

Although the ELC does not explicitly address ecological connectivity, it provides a framework that can support actions for such an issue through landscape planning and management (Kettunen et al., 2007). Furthermore,

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scientific literature has acknowledged (1) that "landscape planners are asked to present models for land use systems that ensure a better connectivity of habitats for endangered species" (Kleyer et al., 1996) and (2) the need for LF analysis integrated into regional planning (Girvetz et al., 2008). According to Romano and Zullo (2012), "[m]aintaining current conditions of continuity, and even restoring and improving them, requires adequate territorial management and more targeted forms of planning than those currently adopted in Italy [and] reduction of fragmentation and biodiversity conservation require forms of governance that consider land in its entirety (urban policy approach) [...]".

Thus, the RLPs could include studies on LF as part of landscape analysis to provide planners, stakeholders and decision-makers with information about the necessity of defragmentation measures in areas with high values of LF and where actions for recovering (or maintaining) of ecosystem continuity need to be planned and implemented.

4 METHOD

Previous studies report on plans that deal with ecosystems fragmentation. For example, Di Ludovico et al. (2000) briefly report on Italians case study such as the Provincial Territorial Plan of Siena (Tuscany), the Urban Territorial Plan of Umbria, and the Territorial Plan of Valle d'Aosta (Fabietti et al., 2011). However, scientific literature shows a lack of studies that focus on LF addressed in last generation RLPs in Italy. Thus, we start investigating such plans against four basic criteria (CR) listed in Tab. 1.

CODE	CRITERIA	MAIN QUESTION UNDERLINED
CR1	Reporting	Does the RLP include information, data, and studies about LF?
CR2	Qualitative or quantitative methods	… adopt qualitative or quantitative methods for assessing LF?
CR3	LF metrics	… list and describe LF measures?
CR4	Defragmentation measures or strategies	… address defragmentation measures or strategies?

Tab. 1 Criteria used for scrutinizing the plans

CR1 aims at providing an overview about LF, that is, reporting on information, data, and studies concerning landscapes integrity compromised by transport and mobility infrastructures, urbanized areas, deforestation, and so on. CR2 provides information about qualitative or quantitative methods used for assessing LF. CR3 describes metrics (e.g. Mean Patch Size, Number of Patches, Median Patch Size) for measuring LF. Finally, CR4 reports on defragmentation measures (e.g. wildlife crossing structures) or strategies (e.g. Natura 2000 networks or ecological networks) able to recover and reconnect isolated or disconnected habitat patches.

5 CASE STUDY: RESULTS AND DISCUSSION

We investigate to what extent LF has been considered in the last generation RLPs. In this preliminary phase, we selected four regions whose landscape plans were approved thus in force and freely available on-line: Apulia, Lazio, Lombardy, and Sardinia (Fig. 1).

In Tab. 2, we report on the scrutiny of the RLPs against the criteria discussed in section 4.

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Fig. 1 Geographic context: in gray, the island of Sardinia and -from North to South- Lombardy, Lazio, and Apulia

REGIONS	PLANS	YEAR	CR1	CR2	CR3	CR4
Apulia	Landcscape territorial plan	2013	Yes	Quantitative method	Metrics are not described in the plan, but they are proposed and applied in the environmental report (Strategic Environmental Assessment): Shannon Diversity Index, Area Weighted Mean Shape Index, Mean Patch Size, Number of Patches, Median Patch Size, Patch Size Standard Deviation, Total Landscape Area.	Regional Ecological Network.
Lazio	Regional territorial landscape plan	2007	References to connection of natural areas	-	-	-
Lombardy	Regional landscape plan	2010	References to ecosystem fragmentation; fragmentation and loss of ecosystem continuity; ...	-	-	Regional Green Network and Regional Ecological Network.
Sardinia	Regional landscape plan	2006	No	-	-	-

Tab. 2 Scrutiny of the landscape plans

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The RLPs show a lack of interest about LF. The region of Apulia assesses LF through several metrics that are included in the Strategic Environmental Assessment (SEA) report. Lazio and Lombardy briefly report on LF referring to ecosystem fragmentation, connection of natural areas, and loss of ecosystem continuity, but no indices are proposed and LF is not quantitatively measured.

6 CONCLUSION

LF can be considered as one of the most important issues concerning ecosystem continuity and biodiversity loss. LF widely affects the European landscapes, but in Italy it appears as little considered by regional landscape plans, according to the preliminary findings reported in this research. Four last generation landscape plans have been scrutinized against four basic criteria including LF, qualitative or quantitative methods described and applied in the plans, LF metrics, and defragmentation measures or strategies.

The region of Apulia deals with LF in the SEA report, measuring several metrics per landscape units. Thus, such a quantitative approach allows planners, decision-makers and stakeholders to (1) obtain a comparative overview about LF, and (2) plan defragmentation strategies in habitats of value. Most regions do not consider LF as a priority at the landscape planning level.

In the next phases, we aim at analysing further last generation landscape plans, identifying best practices, and proposing guidance to include LF in the landscape planning process.

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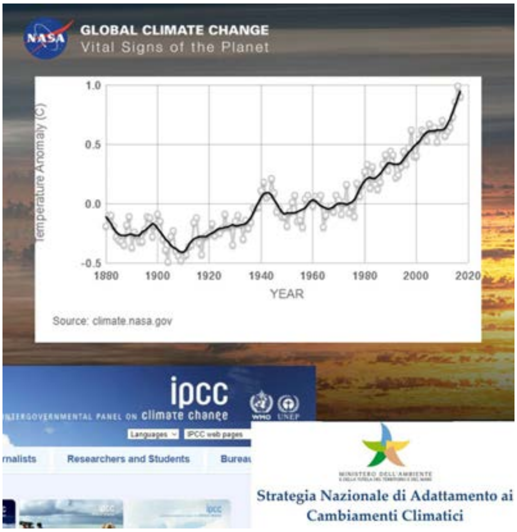

GOVERNANCE AND ADAPTATION TO CLIMATE CHANGE

AN INVESTIGATION IN SARDINIA

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ABSTRACT

Climate change implies increase of temperature, rising of sea level, and more frequent and intense floods and droughts than in the past. All landscapes are impacted by such deleterious events. Effective measures able to prevent or minimize the negative effects of climate change consist of adaptation actions. In 2013, the European Commission adopted the EU Adaptation Strategy that aims at making the European context more climate-resilient. Scientific literature stresses that adaptation to climate change is affected by both hard (legal, economic and technological) and soft (social) factors, which should be all considered by governance approaches to adaptation. This implies coordination and cooperation among the different domains, actors and responsibilities, to avoid or solve conflicts and facilitate choral implementation of adaptation measures.

In this study, we aim at investigating multi-sectoral governance processes involved in the Regional Strategy for Adaptation to Climate Change, which is being designed by the regional administration of Sardinia (Italy). We are interested in proposing major governance models starting from the scrutiny of the main actors currently involved in setting climate change adaptation strategies. In this preliminary phase we report on the mapping of the competences of the regional departments, starting from the results of a questionnaire-based survey, an organizational chart, and an analysis of regional plans.

KEYWORDS

Climate Change adaptation Strategies and Measures; Governance; Regional Plans; Organizational Chart; On-line Questionnaire

1 INTRODUCTION

According to reliable climate data, the Earth's surface has become increasingly warmer in the last three decades "than any preceding decade since measurements began over 150 years ago" (Bush, 2018). Climate change is considered one of the most important issues of the last years and includes effects, such as increasing of temperature, rising of sea level, and frequent and intense floods and droughts (Field et al., 2014). Over time, adaptation measures have been proposed to prevent or minimize the negative effects of climate change and take advantage, when possible. According to Salzmann et al. (2016), "climate change adaptation refers to the adjustment of natural or human systems as a response to actual or expected climatic stimuli or their effects, which moderates harms or exploits beneficial opportunities" and adaptation can be planned, anticipatory, or autonomous. Adaptation measures include crop diversification, early warning systems, and seasonal climate forecasting (Ochieng et al., 2016). Keskitalo (2010) argues that "[c]limate change is a problem that poses high requirements for governance by requiring the coordination of demands and needs across international, national, regional and local scales, as well as coordination between sectors [...]". Governance for climate change adaptation means that "policies and action programmes exist on different levels" and "these [are] coordinated across levels and sectors" (Keskitalo, 2010).

In 2015, the Italian Ministry of the Environment and Protection of Land and Sea approved the National Climate Change Adaptation Strategy (SNACC) (MEPLS, 2015). Such a strategy points out the main impacts of climate change for socio-economic and natural sectors, and proposes adaptation measures. A national adaptation plan is currently being developed (MEPLS, 2017). At the same time, the Autonomous Region of Sardinia (Italy) is developing the Regional Strategy for the Adaptation to Climate Change (SRACC).

In these early stages of our research, we focus on multi-sector governance of climate adaptation in Sardinia, a region where adaptation strategies and measures have been scarcely discussed so far. We aim at identifying the main actors - and the synergies between them – which are explicitly or implicitly involved in setting climate change adaptation strategies or measures. Furthermore, we scrutinize regional plans to figure out to what extent adaptations strategies or measures have been taken into account by the regional administration. The paper unfolds as follows. In the next section, we report on scientific literature concerning governance of climate change adaptation. In the third section, we describe the methodology proposed and applied in this research. In the fourth section, the results are shown and discussed. Finally, section five focuses on the concluding remarks.

2 GOVERNANCE OF CLIMATE CHANGE ADAPTATION

The importance of climate change adaptation measures has grown over time. Indeed, even if the greenhouse gases emissions ceased today, the climate change in progress would continue in the future (Baffo et al., 2009). In 2013, the European Commission adopted a strategy on adaptation to climate change (EU Adaptation Strategy) that aims to make the European context more climate-resilient. The EU Adaptation Strategy focuses on promoting (i) action by Member States, (ii) better-informed decision-making, and (iii) adaptation in key vulnerable sectors (European Commission, 2013). Adaptation to climate change is affected by a series of elements including economic resources and social factors (values, interests, traditions and so on). Scientific literature stresses that hard factors (legal, economic and technological) as well as soft factors (social) should be considered by governance approaches to adaptation, and social factors can be an important barrier that needs to be overcome in implementing adaptation strategies (Grothmann, 2011).

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According to the SNACC (MEPLS, 2015), the adaptation measures can be clustered in three macro-groups: gray, green, and soft measures. Gray measures include technological and engineering solutions, green ones consist of ecosystem-based approaches, while the soft ones include management, legal and political approaches (including governance system). Governance is a key factor "in shaping the process of adaptation" (Wolf, 2011) and "effective adaptation to climate change requires new governance approaches that are able to bridge or even transcend governmental levels and societal domains" (Bauer & Steurer, 2014). Climate change influences several sectors and actors, and scientific literature points out the necessity for coordinated and cooperative adaptation governance to solve or avoid conflicts and implement adaptation measures (Grothmann, 2011; Juhola & Westerhoff, 2011). Runhaar et al. (2017) state that "[m]ainstreaming climate adaptation objectives into existing policies [...] is widely advocated for public action". Thus, adaptation to climate change and governance have been addressed in scientific literature in both European and non-European contexts. As an example, Bauer and Steurer (2014) studied the effects of regional adaptation partnerships in facilitating adaptation to climate change in a multi-level governance context in Canada and England. The authors scrutinized documents such as reports and websites, and performed semi-structured interviews with responsible, managers and key partners involved in the partnerships. In this study, we focus on governance in the climate change adaptation context, aiming at scrutinizing the main actors and factors currently explicitly or implicitly involved in setting climate change adaptation strategies in Sardinia.

3 METHOD

We focus on regional governance of climate adaptation in Sardinia (Fig. 1). In detail, we: (i) use data provided by the Autonomous Region of Sardinia to figure out the level of regional officers' acquaintance concerning adaptation to climate change; (ii) perform an analysis of the official regional website to define the regional organization chart and identify the assignments per Regional Departments (RDs) and Services (RSs); (iii) analyze regional plans to assess if adaptation measures have been included in such documents (Tab. 1).

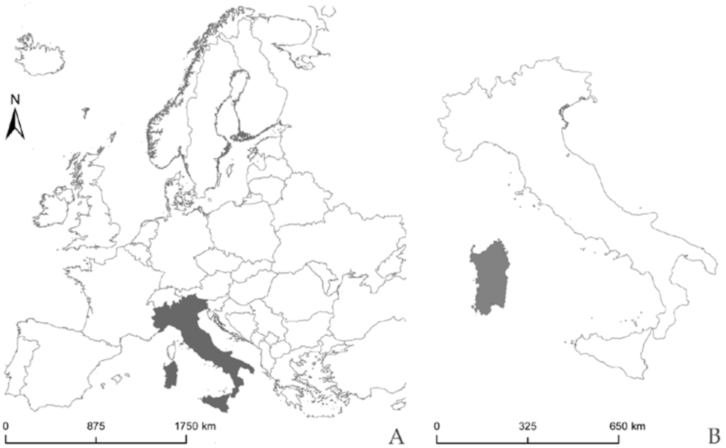

Fig. 1 Geographical context. A: in gray, Italy; B: in gray, Sardinia

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TOPIC	TOOLS	DESCRIPTION
GOVERNANCE AND ADAPTATION TO CLIMATE CHANGE	On-line questionnaire	We use data provided by the Autonomous Region of Sardinia, which were recorded through an on-line questionnaire developed in the context of the Life project 'Master Adapt'. Such data help us to figure out the level of regional officers' acquaintance concerning adaptation to climate change.
	Analysis of official regional website and documents	We draft the organisation chart of the Regional Departments, to identify responsibilities for adaptation measures at the regional level.
	Analysis of regional plans	We scrutinize plans to assess to what extent the adaptation to climate change has been considered in such documents.

Tab. 1 Methods and tools adopted for investigating the current regional governance of climate change adaptation

We scrutinize the plans against four criteria rooted in scientific literature and/or in international/national guidance documents or strategies (Tab. 2).

CRITERIA	DESCRIPTION	REFERENCES
ADAPTATION STRATEGIES REFERENCE	Do the documents refer to national or international climate change adaptation strategies?	European Commission ,2013; MEPLS, 2015
ADAPTATION MEASURES	Do the plans define climate change adaptation measures?	European Commission, 2013; MEPLS, 2015
IMPLICIT OR EXPLICIT MEASURES	Are the adaptation measures implicit or explicit?	Donner et al., 2016
RESPONSIBLE FOR THE IDENTIFIED ADAPTATION MEASURES	Do the plans define responsibilities for adaptation measures?	Mees & Driessen, 2018; MEPLS, 2015

Tab. 2 Criteria selected for analyzing the plans

We aim at checking if the plans refer to national or international climate change adaptation strategies (i.e. EU Strategy and/or SNACC), which define a framework for defining climate change adaptation actions, and if adaptation measures are defined by the plans. We report on implicit or explicit adaptation measures, where implicit measures stand for "activities which can reduce societal vulnerability to external stresses like climate events (e.g., capacity building), but may not be explicitly designed to adapt to a particular range of projected climate outcomes" (Donner et al., 2016). Finally, according to Mees and Driessen (2018), clear responsibilities are key for adaptation governance and, then, we check if responsibilities for adaptation have been assigned.

4 RESULTS AND DISCUSSION

In the context of the Life project MASTER Adapt (MAinSTreaming Experiences at Regional and local level for adaptation to climate change), the Autonomous Region of Sardinia investigated on methodology to activate a mainstreaming action to adaptation to climate change so that regions, metropolitan cities and local authorities can incorporate climate change adaptation (CCA) actions into their plans and programs (MASTER ADAPT, 2018). The results of the project, which will be promoted between the Italian and European regions,

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will be at the basis of the strategic framework of the plan of the regional adaptation to climate changes (PRACC). The method implies, inter alia, the opportunity of working -since the early stages of the PRACC drafting- on three issues: i) involvement of regional structures (departments, agencies and agencies), in a collaborative process aiming at the identification of the objectives and adaptation options to be adopted in the corresponding sector plans and programs; ii) identification of territorial partnerships for adaptation to CC at the intermunicipal (see the Interregional Board for the adaptation of the Environment and Energy Commission of the State-Regions Conference) and regional level (see the inter-departmental coordination board for the adaptation established in 2015); iii) elaboration of strategic projects for adaptation, on a supra-municipal scale, as test case studies in the perspective to define minimum climate unit suitable for the implementation of strategies and adaptation actions identified in the PRACC. The first investigation involves regional officers and aims at ascertaining the level of familiarity with the issues connected to adaptation to climate change. On a sample of 21 answers, part of the respondents claims to know climate change issues well or very well. Four respondents claim to deal with climate change as a relevant part of their tasks. Finally, little attention has been posed on both national strategy and plan for adaptation to climate change (i.e. few respondents specify to have read such documents). As a second step, we recreate the network of regional assignments per RD - which usually consist of RSs - for identifying responsibilities for adaptation measures at the regional level. The Decrees concerning the RSs institution and their respective statutory core tasks have been retrieved on-line. We assessed if such decrees included tasks consistent with the adaptation measures suggested by the SNACC, with focus on governance issues. Such an analysis is still ongoing, but preliminary results show that some adaptation tasks belong (explicitly or implicitly) to the Environment and Agriculture RDs. To perform the third step, we gave priority to the analysis of plans and programs concerning the landscape, water, and agriculture sectors, for they have been identified as priority sectors for the SRACC. We retrieved on-line and scrutinized four regional plans to figure out if such documents included adaptation measures.

Thus, the plans have been analyzed against four basic criteria: (i) presence of explicit reference to national or international adaptation strategies, (ii) presence of implicit and explicit adaptation measures, (iii) specification of the presence of implicit or explicit adaptation measures, and (iv) identification of the responsible authorities for the identified adaptation measures. Tab. 3 reports on the results of such review. The Landscape Plan and the Hydrogeological System Plan described measures that could be considered adaptation measures such as: processes of de-pollution and environmental regeneration, vegetable recolonization in industrial areas, functionality preservation of watercourses, drainage structures, which mainly consist of gray and green adaptation measures.

Overall, two out of four plans explicitly report on adaptation measures. The River Basin District Management Plan explicitly identifies adaptation measures such as: updating and integration of weather-climate data acquisition systems, updating and development of the drought monitoring system, drafting and dissemination of guidelines aimed at saving water in agriculture.

The Flood Risk Management Plan provides prevention and protection measures in synergy with the SNACC, as, where possible, the measures are oriented towards favoring the resilience of the involved systems, in order to support climate change adaptation. The Plan includes both gray and soft adaptation measures. The gray measures include the realization of protective works (e.g. slopes stabilization, relocation of elements due to a given risk), while the soft measures include study and monitoring actions, active territorial maintenance (e.g. improvement of the knowledge of critical hydraulic situations).

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REGIONAL PLAN OR PROGRAM	YEAR	ADAPTATION STRATEGIES REFERENCE	ADAPTATION MEASURES	IMPLICIT OR EXPLICIT MEASURES	RESPONSIBLE FOR THE IDENTIFIED ADAPTATION MEASURES
Regional Landscape Plan [Piano Paesaggistico regionale]	2006	No	Yes	Implicit	Yes
Hydrogeological System Plan [Piano stralcio per l'assetto idrogeologico]	2004	No	Yes	Implicit	Yes
River Basin District Management Plan [Riesame e aggiornamento del piano di gestione del distretto idrografico della Sardegna]	2016	No	Yes	Explicit	Yes
Flood Risk Management Plan [Piano di Gestione Rischio Alluvioni]	2016 (update 2017)	EU strategy on adaptation to climate change Italian Strategy for Climate Change Adaptation	Yes	Explicit	Yes

Tab. 3 Analysis of regional plans: findings

5 CONCLUSIONS

In this study, we focus on the governance of adaptation to climate change in Sardinia, a region where the interest in adaptation is still in its infancy. We analyze the current adaptation regional scenario, identifying responsibilities for adaptation measures at the regional level and assessing to what extent the adaptation to climate change has been considered in regional plans and programs.

This study can be considered as an early base for more systematic analyses. Preliminary results show that, in general, despite some RSs are (explicitly or implicitly) responsible for adaptation tasks, regional officers do not always have complete awareness about their competence in such a domain. Finally, although implicitly, the regional plans analyzed so far contain adaptation measures.

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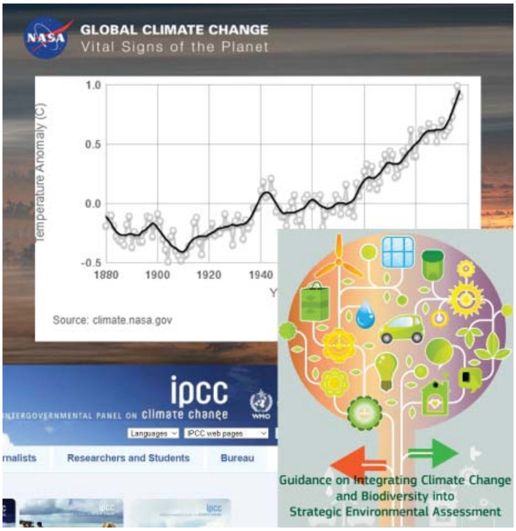

INTEGRATING CLIMATE CHANGE ADAPTATION INTO SEA

AN ASSESSMENT FOR SARDINIA, ITALY

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ABSTRACT

Climate Change (CC) is recognized as an urgent concern, which implies negative effects on the environment, such as sea level rise, coastal erosion, flooding, droughts, and desertification. It involves not only the environmental, but also the economic, and social sphere. The impacts of CC are addressed through two complementary strategies: mitigation and adaptation. The first one operates on the reasons of CC aiming at preventing or reducing greenhouse gases emissions, while the second one focuses on the damage they can cause, aiming at minimizing it or to take advantage of opportunities that may occur.

Strategic Environmental Assessment (SEA) represents a systematic and participatory decision-making support process, aiming at integrating environmental considerations in the elaboration of plans and programs. While SEA regards explicitly mitigation strategies, so far it still refers marginally to CC adaptation measures to be carried on when implementing spatial planning tools at the regional and local scale. The integration of SEA processes with concepts inspired to adaptation to CCs represents a powerful tool for mainstreaming the corresponding policies and strategies. In this study, we scrutinize SEA and spatial planning tools issued in Sardinia (Italy), with reference to their attitude to incorporate possible climate adaptation concerns. We are interested in proposing and applying a framework based on internationally acknowledged criteria that need to be met to properly implement climate change adaptation measures and actions in current spatial planning and SEA practices.

KEYWORDS

Climate Change; Strategic Environmental Assessment; SEA Report

1 INTRODUCTION

According to the Italian National Strategy for Adaptation to Climate Change (SNACC), over the next decades, the impacts resulting from climate change in the European Mediterranean region will be particularly negative. These impacts, in combination with the effects of human pressure on natural resources, make this area one of the most vulnerable in Europe. Therefore, it is necessary, in addition to defining climate change mitigation policies and strategies, to introduce adaptation measures, aimed at countering the effects of climate change in the best possible way, in spatial planning policies both at the local and the global scale. Strategic Environmental Assessment (SEA) aims at assessing the effects of certain plans and programs on the environment and could be "vehicle for the implementation of climate protection within spatial planning ([Blanco et al., 2009]), [...]" (Wende et al., 2012). Then, in this paper we aim at: i) assessing if and to what extent SEA reports address climate change adaptation issues, and ii) highlighting critical factors that need to be dealt with in the Regional Strategy for Adaptation to Climate Change (SRACC).

The paper is organized as follows. The second section gives a brief description of the SEA and climate change adaptation issues based on literature review, while the third section illustrates the study methodology, which investigates the state of the art of climate change adaptation integration in Sardinian SEAs. Then, the fourth section highlights the results of this preliminary analysis, while the last section illustrates the concluding remarks and some elements for future research.

2 STRATEGIC ENVIRONMENTAL ASSESSMENT AND CLIMATE CHANGE

The Directive 2001/42/EC (SEA Directive) has officially introduced the SEA within the European Union as a mandatory procedure for plans and programs, which goes with the decision-making process since the early stages of elaboration with the aim to govern territorial development according to sustainable principles. The SEA aims at assessing the effects of certain plans and programs on the environment, integrating environmental considerations into the design of planning and programming tools (European Parliament and Council, 2011). SEA promotes a significant methodological innovation in the plan-making process, aiming at enriching it with environmental considerations and public participation. During the process, the SEA Report shall be produced, in order to document the results of the analyses carried out, including the description of significant expected effects on the environment (including those ones linked to biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors), and encouraging public participation and transparency. The Intergovernmental Panel on Climate Change (IPCC) states that "human influence on the climate system is clear and growing, with impacts observed across all continents and oceans" (Pachauri & Meyer, 2014). Climate change has been acknowledged "as one of the major environmental challenges of the global society" (Larsen et al., 2012) and includes effects such as increase of temperature, rising of sea level, and more frequent and intense floods and droughts than in the past (Pachauri & Meyer, 2014). Over time, adaptation measures have been proposed to prevent or minimize the negative effects of climate change and take advantage when it is possible. According to Salzmann et al. (2016), "climate change adaptation refers to the adjustment of natural or human systems as a response to actual or expected climatic *stimuli* or their effects, which moderates harms or exploits beneficial opportunities". Adaptation measures include crop diversification, early warning systems, and seasonal climate forecasting (Ochieng et al., 2016).

In 2013, the European Commission adopted an EU strategy on adaptation to climate change (EU Strategy), which focuses on the promotion of three main targets: (i) action by Member States, (ii) climate-proofing action

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at EU level, (iii) better informed decision-making (European Commission, 2013a). The EU Strategy consists of several documents, including the one 'Principles and recommendations for integrating climate change adaptation considerations under the 2014-2020 rural development programmes'. According to such a document, "[so] far, SEA has been designed to assess impacts on the environment, rather than viceversa – e.g. to assess impacts of a changing climate on a programme. However, climate change impacts are closely related to the environment and, typically, biodiversity and ecosystems" (European Commission, 2013a). The European Commission remarks the need for considering climate change impacts in implementing: (i) European Directives on environmental assessments (i.e. Environmental Impact Assessment and SEA), and (ii) spatial planning policies (Commission of the European Communities, 2009). Since the purpose of SEA is to encourage transparent and environmental informed decision-making processes (Fundingsland Tetlow & Hanusch, 2012), SEA is acknowledged as "the vehicle for the implementation of climate protection within spatial planning ([Blanco et al., 2009]), [...]" (Wende et al., 2012). Furthermore, in 2013 the European Commission released the 'Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment' (European Commission, 2013b).
In this study, we aim at investigating whether in Sardinia the SEA Reports of regional plans and programs deal with climate change adaptation issues. Moreover, we want to verify whether adaptation-driven SEA processes lead to drafting plans and programs focusing on climate change adaptation issues.

3 METHOD

In this study, we scrutinize SEA Reports of regional plans and programs in Sardinia (Fig. 1), Italy, for assessing to what extent climate change adaptation has been taken into account during the plan elaboration process, in order to integrate the plan main objectives. Three SEA Reports were selected, among the most recent adopted plans, and checked to verify if adaptation strategies and measures are considered.

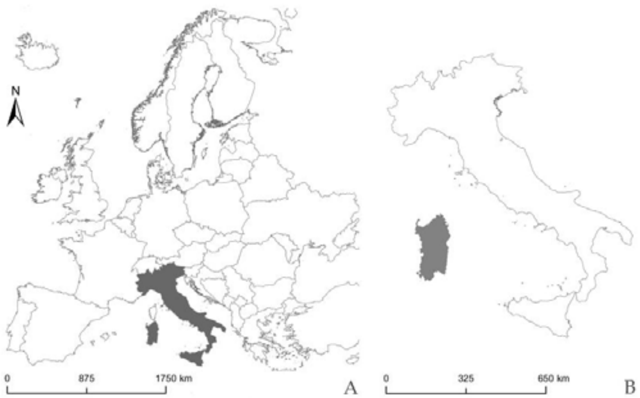

Fig. 1 Geographical context. A: in gray, Italy; B: in gray, Sardinia

The SEA Reports have been analyzed against four basic criteria (Tab. 1): (i) outline of (and relation with) the main objectives of national or international climate change adaptation strategies, (ii) presence of a climate analysis at the regional level, (iii) identification of adaptation objectives to be included in the plan, and (iv) description of implicit or explicit adaptation objectives.

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CRITERIA	REFERENCES	KEY POINTS
REFERENCE TO ADAPTATION STRATEGIES	European Commission, 2013; MEPLS, 2015	National or international climate change adaptation strategies
CLIMATE ANALYSIS	(Prutsch et al., 2010)	Climate analysis, regional level
ADAPTATION OBJECTIVES	(Prutsch et al., 2010)	Adaptation objectives
IMPLICIT OR EXPLICIT MEASURES	(Donner et al., 2016)	Implicit or explicit adaptation measures

Tab. 1 Analysis of ERs: method

We aim at checking if the SEA reports refer to national or international climate change adaptation strategies (i.e. EU Strategy and/or SNACC), which define a framework for defining climate change adaptation actions. Prutsch et al. (2010) argue that the potential effects of climate change need to be assessed and a series of factors have to be considered, including "[a]nalyse the impacts of past weather events and recent climate trends on key systems" (Prutsch et al., 2010), thus we check if the ERs include a climate analysis. According to Prutsch et al. (2010) "adaptation options should be characterized in as much detail as feasible including information about objectives, direct and indirect effects with emphasis on potential benefits [and so on]". Then, we check if adaptation objectives are defined. Finally, we report on implicit or explicit adaptation measures, where implicit measures stand for "activities which can reduce societal vulnerability to external stresses like climate events (e.g., capacity building), but may not be explicitly designed to adapt to a particular range of projected climate outcomes" (Donner et al., 2016).

4 RESULTS AND DISCUSSION

We find out that the SEA Report of the Flood Risk Management Plan refers explicitly to the SNACC while outlining the contents and the main objectives of the other relevant plans and programmes, as required by Annex I to the SEA Directive. It clarifies how the Plan transposes the principles brought by the SNACC, through the implementation of a set of structural and non-structural measures. It also reports on a general climate analysis at the regional level without reference to past and current climate trends. The SEA Report of the Regional Energetic and Environmental Plan describes the impacts of climate change on the energy sector, such as extreme weather events, heat waves and projections on annual rainfall changes. Moreover, it outlines the relevant SNACC information to be integrated in the Plan objectives. The SEA Report of the Rural Development Programme refers to both SNACC and national climate change adaptation plan (which has not been approved yet), and includes a climate analysis at the regional level. It also shows a set of explicit climate change adaptation measures, including recover of production potential damaged by natural disasters and catastrophic events and definition of appropriate prevention measures, investments for development of forest areas and improvement of forest revenue-generating, agri-climate-environmental payments, and so on. Tab. 2 summarizes the results of the scrutiny. As for the clarification of the causal relation between adaptation-driven SEA processes and focus of planning and programming tools on adaptation measures, we scrutinized how far the same plans and programs consider issues related to adaptation to climate change (De Montis et al., 2018). The aim of this comparison is to understand if the presence of implicit or explicit adaptation measures in each plan/program, is related to the SEA. The results of the comparison are synthetized in Tab. 3. All plans and programs but the first one explicitly refer to climate change adaptation measures and so do the related SEA Reports. The SEA of the Hydrogeological System Plan has not been carried out yet. The ERs report on climate change adaptation objectives, according to European and national guidance. Thus, as far as

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the analysis of the tools considered suggests, there is a correspondence between adaptation-driven SEA processes and planning tools focus for adaptation measures.

Plans evaluated	YEAR	ADAPTATION STRATEGIES REFERENCE	CLIMATE ANALYSIS	ADAPTATION OBJECTIVES	IMPLICIT OR EXPLICIT MEASURES
Flood Risk Management Plan (PGRA)	2016	EU strategy on adaptation to climate change Italian national strategy on adaptation to climate change	Yes	Yes	Explicit
Regional Energetic and Environmental Plan (PAES 2015-2030)	2015	Italian national strategy on adaptation to climate change	Yes	Yes	Explicit
Rural Development Programme 2014-2020 (PSR)	2015	EU strategy on adaptation to climate change Italian national strategy on adaptation to climate change	Yes	Yes	Explicit

Tab. 2 Analysis of SEA Reports by plans and programs: findings

REGIONAL PLAN OR PROGRAM	YEAR	IMPLICIT OR EXPLICIT ADAPTATION MEASURES	SEA	ADAPTATION QUOTED IN THE SEA REPORT
Hydrogeological System Plan [Piano stralcio per l'assetto idrogeologico]	2004	Implicit	No	No
Flood Risk Management Plan [Piano di Gestione Rischio Alluvioni]	2016 (update 2017)	Explicit	Yes	Yes
Regional Energetic and Environmental Plan [Piano energetico ed ambientale]	2015	Explicit	Yes	Yes
Rural Development Programme [Programma di Sviluppo Rurale]	2015	Explicit	Yes	Yes

Tab. 3 Final comparison

5 CONCLUSIONS

In this study, we investigate if and how far the issue of climate change adaptation is addressed in the most recent SEA of regional plans and programs in Sardinia, through the examination of their respective SEA Reports. The analysis highlights that climate change adaptation considerations are beginning to influence, implicitly or explicitly, planning practices also thanks to the availability of sectorial national and international strategies (i.e. EU Strategy and SNACC), underlining the importance of developing the Sardinian SRACC.

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Notwithstanding this is a preliminary study, we found out that SEA represents a useful instrument to integrate environmental considerations related to climate change adaptation into the objectives of plans and programs.

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MODIS DATA FOR DETECTION OF LANDSCAPE CHANGES

BY OIL PALM PLANTATIONS IN BORNEO

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ABSTRACT

Elaeis guineensis Jacq. is a palm species of the Arecaceae's family commonly called Oil palm; it is planted extensively in South-East Asia. Palm oil is the world highest yielding oil crop. Cultivation of oil palm in tropical countries, on one hand is an important economic factor, but, on the other hand, it endangers biodiversity and degrades the environment with a global impact. From this point of view, remote sensing can support a more efficient plantation management that takes into account their effects over environment. MODIS EVI maps obtained from the MODIS Vegetation Index, 16 days composite product (MOD13Q1), were used to monitoring tropical vegetation. In this work a EVI time series, covering 18 years, was processed to automatically detect new oil palm plantations an also giving an estimate of the age. The proposed methodology is simple enough, since automatic, to be retained useful to many stakeholders: governmental institutions and environmental associations could use it to continuously monitoring the state of the national natural/crop capital; landscape/territory planners can use it to read and drive pattern of changes; private owners and local farmers could be interested in assessing crop conditions for precision farming (a further improvement should be done).

KEYWORDS

Oil Palm; MODIS, EVI; Time Series Analysis; Plantation Age; Palm Detection; Borneo

1 INTRODUCTION

Elaeis guineensis Jacq. is a palm species of the *Arecaceae's* family commonly called Oil palm; it is planted extensively in South-East Asia, especially in Malaysia, Thailand, and Indonesia. These regions represent the 11% of the world's remaining tropical forests (Iremonger et al., 1997), containing endemic or rare forest habitats (Koh, 2007; Mittermeier et al., 2004; Sodhi et al., 2004). Cultivation of oil palm in these tropical countries, on one hand is an important economic factor, but, on the other hand, it endangers biodiversity and degrades the environment with a global impact (Koh & Wilcove, 2008).

Palm oil is the world highest yielding oil crop. Specifically, in Indonesia, plantations showed an increasing linear trend between 2000 and 2014 (Chong, 2017).

Respectively the consumption of palm oil over the world is growing through the years: 55 Million to 60 Million tons between 2012 and 2016 (Chong, 2017). Oil palm is a perennial tree well fits the humid tropical climate (Corley & Tinker, 2008). Plantations generally show a triangular pattern (9 m row spacing) aimed at optimizing sunlight penetration (Basiron, 2007). The majority of planted oil palms are clones (Chong, 2017) resulting in a uniform pattern that makes oil palms areas different from natural forest in satellite imagery (Shafri et al., 2011). From this point of view, remote sensing can support a more efficient plantation management that takes into account their effects over environment. Plantations monitoring by remote sensing well fits requirements of precision farming that many stakeholders are currently approaching to decrease environmental impacts. Among the available remotely sensed data, the NASA's sensors MODerate resolution Imaging Spectroradiometer (MODIS) onboard the Terra and Aqua satellites have been widely used in a variety of studies (Colombo et al., 2011; Hmimina et al., 2013; Soudani et al., 2008; Testa et al., 2018; Zhang et al., 2003).

Thanks to the two twin MODIS instruments, MODIS data are acquired globally twice per day per instrument at the spatial resolutions of 250 m, 500 m and 1 km at nadir, depending on the spectral band. MODIS imagery is distributed at various pre-processing levels and, with respect to the temporal resolution, data are released as both daily and composites products, the latter generated at different compositing steps (8 -day, 16-day, monthly). Composite data have some advantages respective to daily data because the compositing process strongly reduces the effect of clouds, snow and noise (Solano et al., 2010). In this work a time series of EVI (*Enhanced Vegetation Index,* Huete et al., 1999) maps, covering the period 2000–2018, was generated from the MODIS Vegetation Index products (MOD13Q1-v5) with the aim of automatically detecting new oil palm plantations and possibly giving an estimate of their age.

EVI spectral index has proved to be more effective in mapping vegetation in those situations where atmospheric scattering and vegetation vigor are high, and background contribution to signal is not negligible (Hufkens et al.,2012; Xiao et al., 2003). These are exactly the conditions that can be found in the Borneo area, therefore suggesting the adoption of EVI in place of the ordinary NDVI (*Normalized Difference Vegetation Index*).

2 MATERIALS AND METHODS

2.1 STUDY AREA

The study area (Fig. 1) is sited in the South of Kalimantan Tengah (Central Kalimantan), a province of Indonesia located on Borneo island (2°53'57.58"S - 112°22'6.47"E, WGS-84 reference frame).

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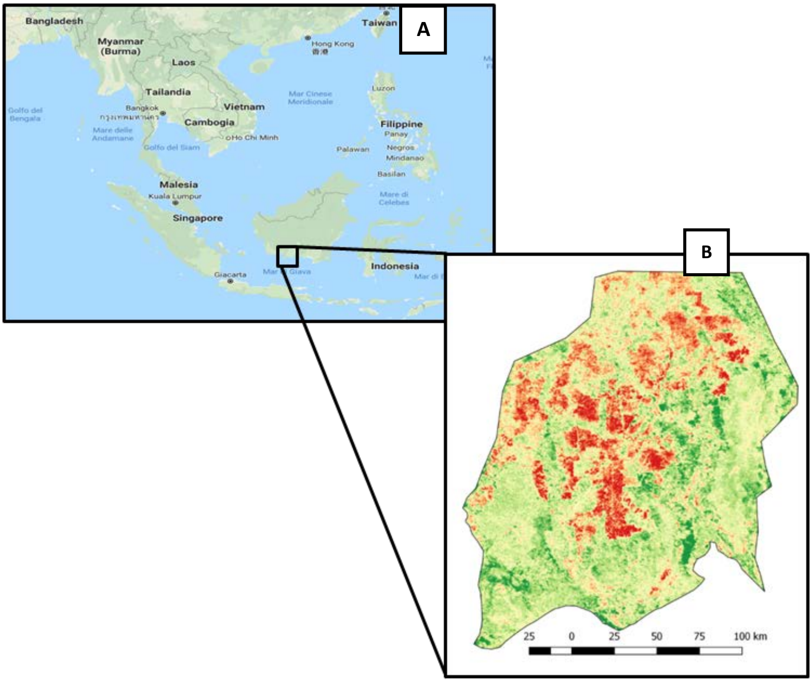

Fig. 1 Study area. A) Indo-China zone. B) Gain value map of study area

Study area was determined on landmarks basis (rivers, sea shore, etc.) resulting in about 2.95 million hectares. Morphology is generally flat with no significant reliefs; some microclimatic conditions can however be found conditioning vegetative activity of plants.

2.2 DATASET

An EVI (Enhanced Vegetation Index) image time series (hereinafter called ETS), composed of 415 images, and covering the period 18/02/2000-18/02/2018 was generated from the MOD13Q1-v5 dataset available from the NASA LPDAAC collection (Solano et al., 2010). The Global Forest Change (GFC) 2000–2016 dataset-v1.4 (Hansen et al., 2013) was also obtained from the *Hansen/UMD/Google/USGS/NASA* system in raster format. GFC is divided into 10x10 degree tiles, consisting of seven files per tile. All files contain unsigned 8-bit values and have a spatial resolution of 1 arc-second per pixel (approximately 30 meters per pixel at the equator).

For this work the following GFC layers were used: a) the Global forest cover loss 2000–2016 (loss, hereinafter called GFC-L) layer was used representing the forest loss during the period 2000–2016, defined as a stand-replacement disturbance, or a change from a forest to non-forest state. Encoded as either 1 (loss) or 0 (no loss); b) the Year of gross forest cover loss event (*lossyear*, hereinafter called GFC-YL), defined as a disaggregation of total forest loss to annual time scales. Encoded as either 0 (no loss) or else a value in the range 1–16, representing loss detected primarily in the year 2001–2016, respectively. Bothe GCF raster layers were preventively projected into the WGS84 UTM 49 S reference system, setting a Ground Sampling Distance (GSD) equal to 30m.

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2.3 MAPPING OIL PALM PLANTATIONS

A new methodology for oil palm plantations detection and characterization (in terms of age) was developed based on EVI temporal profile analysis of ETS pixels. Local EVI profile is assumed to describe vegetation macro-phenology; the detection algorithm is in charge of exploring it looking for an abrupt change in EVI values (sudden decreasing). Candidate pixels representing newly planted oil palms were detected with reference to the 1st order polynomial approximating by regression EVI local values in the whole reference period; gain value of the local line was assumed as predictor of new oil palm plantations and saved in a new image layer. It was noted that in tropical areas, new palm plantations determine steeper (positive) regression lines than natural vegetation that did not change in the considered period.

In general can be observed that when natural vegetation is constantly present, yearly EVI trend is slightly varying with no remarkable profile steep trait, determining gain value close to zero. Differently, if a new plantation occurs, EVI temporal profiles suddenly decreases at the moment of forest cut, but, after a transitional period, it reaches a new state of vigor corresponding to higher EVI values. The abrupt EVI value decreasing that occurs when natural vegetation is cut, the consequent oil palm planting and growing determines a significant increasing of line gain, in general higher than 2.0. To extract ETS pixels that potentially suffered from vegetation change, from natural vegetation to oil palm, the above mentioned gain value image layer was therefore thresholded with reference to this value, obtaining a rough map of new oil palm plantations with the following classes: 1= Oil Palm (OP), 0 = Not-OP (NOP).

Raster classification was finally vectorised and refined deleting (by ordinary GIS vector map editing tools) all those polygons smaller than 100 ha, being declared plantation average size in general higher of this value, typically following a rectangular pattern of 1000 m x 300 m. Classification accuracy assessment was achieved with reference to GFC-L. Refined vector map (Fig. 3-[A]) was converted back to the raster format by nearest neighbor resampling, making it consistent with GCF-L (GSD=30 m). It is worth to remind that GFC-L represents the forest loss occurred in the period 2000-2016, that authors assumed to be potentially and totally due to new oil palm plantations in the same period. In fact, in this region new palm plantations are the first reason of forest loss (Curran et al., 2004), making this assumption reasonable. Image processing for oil palm plantations detection was achieved by self-developed routines implemented in IDL 8.0 and free GIS software (QGIS 2.18.4 and Saga GIS 6.2).

2.4 ESTIMATING STARTING DATE AND AGE OF PLANTATIONS

The age of oil palm plantation is an important parameter for crop management: it is a good predictor of yearly yield and conditions the quality and quantity of the *fresh fruit bunches* (FFB). According to the above mentioned classification, ETS profile of all the OP pixel were analyzed at year level looking for the moment of the forestry loss preceding oil palms plantation.

ETS profiles were explored by a sliding window (kernel) including 23 EVI values: 11 preceding (about six months) and 11 following the one the kernel was centered around. EVI values successively included within the window were approximated by a 1st order polynomial (by Ordinary Least Squares estimation) recording the correspondent gain value in a temporary array, i.e. the Local Gain value Time Series (LGTS, Fig. 2).

It was found that the minimum value of the LGTS was a reasonable predictor of the moment of the forest loss at that position. For each OP pixel an estimate of the year when the new plantation was supposed to start was computed according to the above mentioned minimum value criterion. A new image layer was therefore generated containing the estimate of the year when the cut occurred (Fig.3-[B]).

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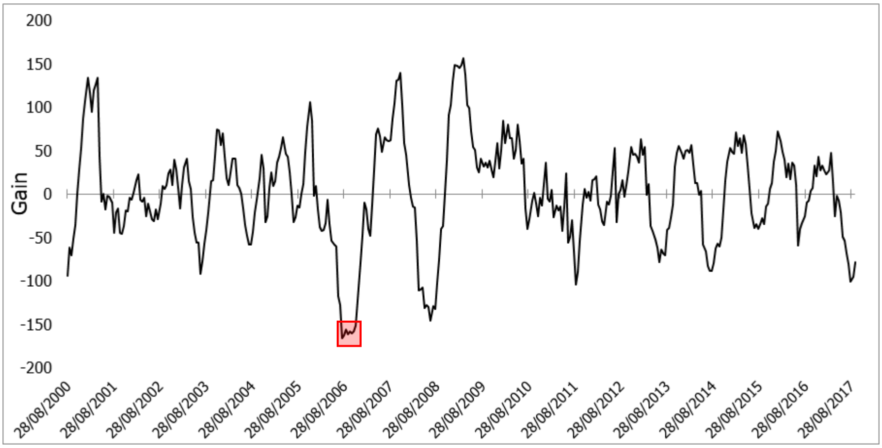

Fig. 2 An example of the Local Gain value Time Series (LGTS) of a generic OP pixel. The moment when LGTS is minimum (red) is assumed as the moment of the forest loss (intermediate date between the beginning and the completion of forest cut)

This map is an effective tool to represent new plantation trends in the investigated period and their spatial distribution. The age of plantations from available data was computed by comparing (by differencing) the estimated planting year with the present (2018). Accuracy assessment of plantations age was achieved with reference to GFC-YL by computing the correspondent confusion matrix and limiting the check to the years 2000-2016.

3 RESULTS AND DISCUSSION

Concerning new oil palm plantation detection the proposed method, based on the thresholding of the gain value of the regression line computed along the whole ETS, proved to be effective: overall accuracy was found to be equal to 96%. In the area about 577467 ha (20% of the whole) were converted from forest to oil palm plantations in the reference period (2000-2018).

Gain value of the line interpolating the entire ETS at pixel level proved to be a good discriminant to map vegetation changes and, in particular, those where the following succession occurred: forest vegetation-cutting-oil palm plantation. In fact, replacement of forest with other surface types (e.g. urban or bare soil) would have determined lower, possibly negative, values of gain and not highly positive as the threshold value proposed in this work.

Estimation of plantations age proved to be more critical; transition matrix was calculated by difference between map of plantations age estimates and GCF-YL. Relate frequency histogram showed that only 20% of detected plantations were correctly dated.

Nevertheless, if we consider a sliding window including 12 months (6 proceeding and 6 following the kernel) we have an estimate uncertainty equal to 1 years.

Thus, we tolerated all errors follow between ±1 year ranges. Analyzing cumulative frequency histogram (Fig. 4), only 36% of the observations follow in a tolerant range.

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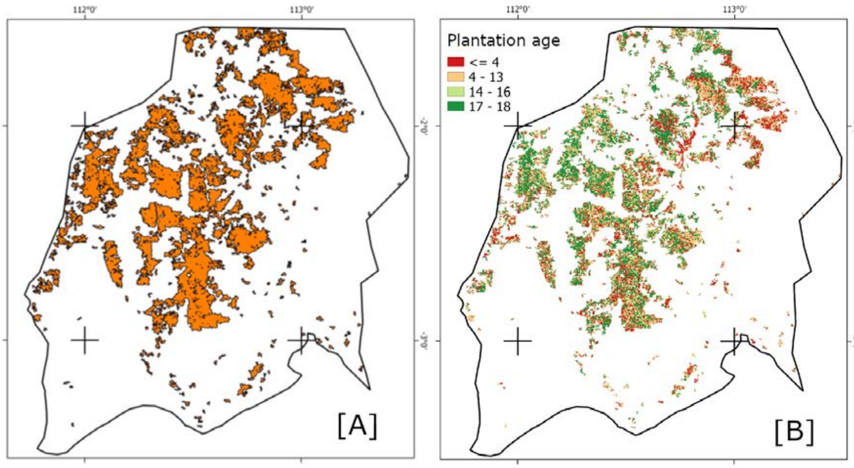

Fig. 3 [A] Classification of oil palm plantations (OP, orange) started in the considered period 2000- 2018. [B] Map of the estimates of the age of detected oil palm plantations. Only plantation that started between 2000-2018 can be mapped. Reference frame of figure is Geographic WGS84

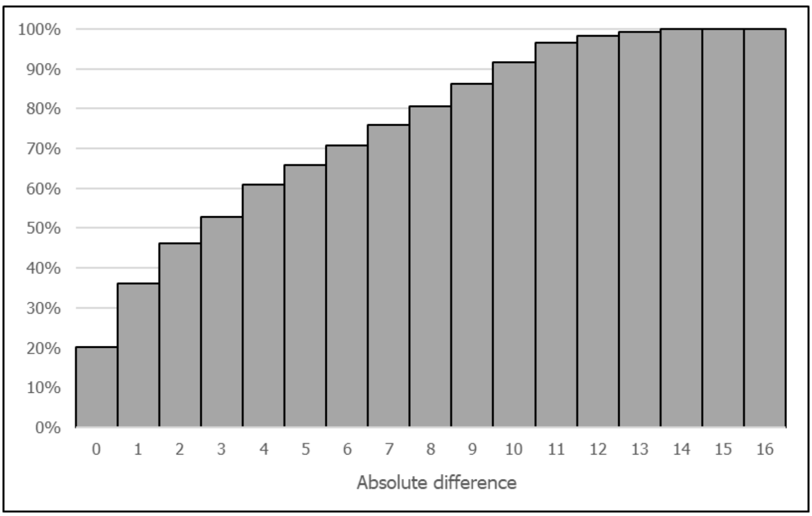

Fig. 4 Cumulative frequency histogram (absolute difference) of transition matrix obtained by difference between Estimate starting moment map and reference map

4 CONCLUSIONS

This work was aimed at mapping areas potentially interested by new oil palm plantations in the Borneo in the period 2000-2018 trying to give an estimate of the date of forest loss/new plantation starting. The proposed method was based on EVI image time series obtained from the MODIS MOD13Q1 (v5).

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The proposed methodology, was consciously thought simple and automatic. It proved to be effective in mapping abrupt changes in forest cover and, in particular, those changes where a previously existing vegetation, after cutting, was replaced with another one. As usual in remote sensing, the correct interpretation of the mapped changes can only rely on auxiliary information available for the area.

Detected changes in vegetation cover could, in fact, be also related to abiotic or biotic disturbance like wildfire, plant diseases, human clear cut. Mapped changes were, therefore, possible to be labelled as "new oil palm plantations", only on a probabilistic basis; the area, in fact, is known to be heavily, and almost solely, affected by forest cut for planting of new palms aimed at oil production.

In spite of this important consideration, often neglected by remote sensing users, the method proved to be accurate enough with an overall accuracy of 96 %.

At the moment, the proposed method appears to be still not satisfying to correctly estimate the starting date of detected new plantations: only 36% of detected plantations were satisfyingly dated (± 1 year). Nevertheless map of plantation starting date, once refined, is retained to represent a good tool to monitor landscape transformations.

Future investigation will try to minimize ETS outliers and use minimum value criterion on ETS to make possible give a more accurate estimation of the starting date and, consequently, of new productions in the area if a unitary production curve is available.

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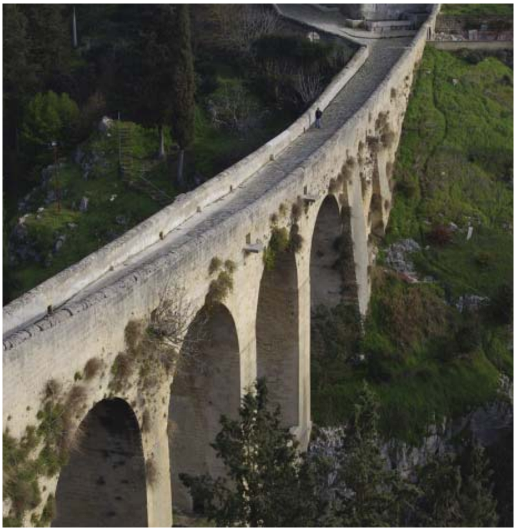

WATER TECHNOLOGIES AND RURAL LANDSCAPES IN THE APULIA REGION

MULTI-SECTORAL AND MULTI-FUNCTIONAL APPROACHES TO ANALYSIS AND PLANNING

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ABSTRACT

Rural landscapes in the Apulia region have been strongly influenced by changes in water technologies and practices occurred in the XX century, which led to the construction of the largest aqueduct in Europe and to a complex system of tamed waterscapes across the region. Modernization was conceived of as a means to free local communities from water scarcity and poverty. Nevertheless, scarcity never ended in the region, as it is entangled with a development approach based on the linearization of ecological processes, whose negative impacts on ecological and socio-economic aspects are more and more evident.

Starting from a critique of this development approach, the paper discusses the innovation potentials rooted in multi-sectoral and multi-functional approaches to water and rural development analysis and planning. For this purpose, reference is made to the new territorial-landscape plan of the Apulia region, which has developed strategic projects fostering integrated approaches to natural resources and landscape analysis and planning. Pilot experiments carried out in the Apulia region for the revival of traditional technologies for water supply and for the implementation of a circular approach to resources management are also described, which suggest interesting innovation pathways to increase resilience and multi-functionality of water technologies and rural development.

KEYWORDS

Rural Landscapes; Water Technologies; Landscape Policies and Planning; Multi-functional Approaches

1 INTRODUCTION

Key changes in rural landscapes in the Apulia region are closely linked to changes in water resources management and planning, as these not only influence crop-cultivation potentials and choices, but have deep implications on environmental aspects and on the way local communities conceive of development patterns and visions, as shown in this paper.

In Apulia, a process of radical technological change in the water sector took place in the post-Unification period, leading to the construction of the largest aqueduct in Europe[1] and to a large-scale system of dams and water works for multiple purposes. This made pre-existing traditional technologies and practices for water harvesting almost completely defunct. The construction of the Apulian aqueduct started in 1904 from the visionary ideas of Camillo Rosalba, which bared to divert water from a nearby region and to carry up to 6,500 l/sec of water through a tunnel as long as 55 km beneath the Apennines and yet another one 16 km below the Murgia, taking a course of about 250 km, from Caposele to Villa Castelli, in a pipeline which distributes water under natural load. At that time, that effort seemed "verging on madness, a challenge to nature" (Viterbo, 2010) even to worthy men of science, while later became in the popular imagination that "work of enduring civilization without equal that has opened up before Apulia a phase of progress exceeding all expectations" (Viterbo, 2010).

This initial masterpiece of work was taken further in the second half of the XX century, by tapping a second spring from the river Calore at Cassano Irpino into the main pipeline and by connecting the main trunk to a complex system of multi-purpose dams feeding the new aqueducts of Pertusillo-Sinni, of Fortore, of Ofanto and of Locone. Today, water from these dams contributes as much as 60% of the total amount of water supplied by the Apulian Aqueduct while only 22% is now harvested from springs, the rest being taken from underground aquifers (AATO Puglia, 2009).

The construction of the Apulian aqueduct was then paralleled in the XX century by a complex irrigation network system made by the newly created *Consorzi di Bonifica* (Land Reclamation Consortia), which took further land reclamation activities carried out since the Borbonic period, when Carlo Afan de Rivera pioneered the works in Capitanata. This produced a gigantic effort of domestication of water, which was particularly impressive in the northern part of Apulia, where the Land Reclamation Consortium of Capitanata produced, since 1933 onwards, a radical infrastructural change in the organization and management of surface water, which had deep impacts on landscape as well as on productive, cultural, social and environmental features (Rienzo, 2012).

Finally, the XX century also saw the widespread dissemination of decentralized systems for groundwater extraction, which were largely conceived of as back-up solutions for irrigation by those who, in the short term, were not able to obtain water through large centralized schemes. The idea that an increase in water supply was an irrefutable right, especially for a population that had long suffered from the lack of water, and the underestimation of the impacts that modern water extraction technologies would have on hydrological cycles and groundwater dependent aquatic ecosystems, de facto led to widespread diffusion and very low public control on such practices. With the final result that today, compared to 873 Mm^3 per year of estimated

[1] With its 20,752 km network and 323 tanks, the Apulian aqueduct today distributes more than 18,500 l/sec of water to a population of over 4,000,000 people (Scagliarini, 2010).

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consumption for irrigation (INEA, 2009), only little more than 200 Mm^3 is provided by the Land Reclamation Consortia, with the rest coming from private wells, which are for the most part illegal[2].

These changes in the water sector had deep consequences not only on natural resources management but also on rural landscapes and on the way people conceived of technological progress and development patterns. In a region traditionally known as thirsty, due to its almost lack of water streams and very low rainfall[3] these changes reinforced the idea that technological progress and modernization were the only way to break free from age-old deprivation, which in the past had condemned people to unhealthy practices and constrained development patterns[4]. The analysis of the conditions, strategies and consequences of the process of radical technological change undertaken in the water sector in the XX century will be the starting point of this paper (section 1), with the aim to show the deep environmental problems and cultural changes they produced. In the second section, the paper will then analyze some examples of traditional rural landscapes of the Apulia region and the way they embody a more resilient and multi-functional approach to water resources management. Finally, the paper will discuss the innovation potentials rooted in multi-sectoral and multi-functional approaches to water and rural landscape analysis and planning proposed by some pilot initiatives across the region and by the strategic vision and projects promoted by the new territorial-landscape plan of the Apulia region.

2 BEYOND TECHNOLOGY: ENVIRONMENTAL, KNOWLEDGE AND CULTURAL DIMENSIONS OF CHANGE

The construction of the Apulian aqueduct has been traditionally conceived of as the "grand solution" (Viterbo, 2010) largely invoked by local communities to ultimately solve water supply problems in the region. Its construction has been widely analyzed from an historical and political perspective as a process of induced modernization by a new alliance between the most productive and upwardly mobile sections of society with a new idea of the state as "political entrepreneur" (Masella, 1995). But this is not the focus of this article, whose interest lies more on the interplay between technological changes, resource management and changes in the tangible and intangible features of the rural landscapes.

The complex multi-sectoral water network, of which the Apulian Aqueduct represents one of the main pillars, has contributed decisively to bringing about dramatic changes in standards of living and patterns of development within a region traditionally considered to be unable to match the pace of the civil and economic development of the country and constrained within backwardness by the absence of any possibility of irrigating the countryside, which led to the forced choice to grow extensive cultivations of grain (Masella, 1995). The

[2] Irrigation in Apulia is supplied at more than 75% from private wells (Distretto Idrografico dell'Appennino Meridionale, 2010). This makes planning and management of this sector an extremely complicated task.

[3] As early as the 1st century BC, Horace spoke of "*Apulia siticulosa*" (thirsting Apulia). The strong scarcity of water resources, which was experienced both by the Lombards of Benevento and by the Byzantines settled in different parts of the region in the 7th century AD, even brought about the suggestion that the name Apulia itself was derived from the Greek ἀπώλεια (apoleia), meaning "destruction" or "ruin" (Sirago, 1993).

[4] Engineer Filonardi, who had travelled all around the Bari area between 1878 and 1879 to analyse water related problems and possible solutions, admitted that the need for water in Apulia had reached the proportions of a "real and great social question". Not only did he note the scarcity of water – so that in times of drought it even became necessary to transport it on special trains from Ofanto at huge cost – but also the terrible quality of water normally used for drinking, so that he admitted it was almost an unbelievable luck in the Bari area to have "a glass of water that does not contain[ed] a myriad of insects, which do not even require a lens or microscope to be seen swimming around" (A. Filonardi, *Relazione al progetto di massima per condurre acque in provincia di Bari*, Roma, 1881. [Report to draft guidelines for conveyance of water in the province of Bari, Rome, 1881], quoted in Viterbo (2010).

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rapid improvement of sanitary conditions and the great increase in agricultural productivity started in the second half of the XX century would surely not have been possible had these operations not made vast amounts of water available (Del Monte et al., 1978; Masella, 1995) and in turn allowed for a partial replacement of traditional extensive crops with irrigated crops while extending irrigation practices to crops traditionally dry farmed (INEA, 2013). At the same time, the possibility to supply abundant water allowed the development of large industrial centers such as the chemical plant in Manfredonia, the petrochemical industrial area of Brindisi and the mixed (steel, petrochemical and concrete/cement) industrial settlement of Taranto[5] (Masella, 1995).
But while these changes in agricultural and industrial patterns were considered to be the means to kick-off growth and to free the region from a backward past, on the other hand they generated new and significant demand for water resources. In the agricultural sector, the estimated water consumption for irrigation is about 873 Mm^3 per year (INEA, 2009). These data are even more significant if compared to nearby regions, which have more abundance of water, as today Apulia has even a larger proportion of water-dependent crops on total crops compared to those regions[6]. Some studies are also beginning to question the sustainability of crop and irrigation patterns in the region by analyzing the relations among crops planted, irrigation technologies and the pedoclimatic and hydrological features of the region (INEA, 2009). As for the industrial sector, recent estimates reported a total requirement of 145 Mm^3 per year of water for industrial use (AdBP, 2012). On this point it's impressive to see that in the recent past ILVA Taranto alone had freshwater concessions as high as exceeding 100 Mm^3 per year, although its actual consumption has then dropped to considerably lower levels in more recent years (Grassini, 2012).
The impressive construction of water supply infrastructures was then paralleled, in the second half of the XX century, by the construction of wastewater infrastructures, including wastewater treatment plants, also thanks to special funding from the *Cassa per il Mezzogiorno* (Southern Development Fund). Water cycle management was split into two sectors (water and wastewater sectors) dealt with in a separate and linear matter to improve efficiency. Impressive water/wastewater works were constructed; however, these could never match the growing demand for connections induced by the rapid socio-economic development the region was witnessing. Lacks in the wastewater sector and pollution of water resources were also some of the reasons for the establishment of long-lasting extraordinary administrations in environmental matters towards the end of the XX century.
Huge management problems also occurred in the water supply sector, in connection with the ageing and the extension of the system. Despite the use of advanced technologies to check leakages, the water works system today loses approximately 55% of the 563 Mm^3 of water channeled into the network from various sources (AATO Puglia, 2009). This is coupled with problems of reduction in the capacity of the Sele-Calore springs and in the quantity of water supplied by reservoirs due to periods of low rainfall as well as to massive problems of depletion of ground water quality and quantity, including salinization of coastal aquifers, which required the adoption of drastic actions to reduce groundwater pumping in several areas. As a consequence, the Apulian

[5] The abundance of fresh water sources near Taranto, although at that time not yet available for industrial use, was one of the location factors highlighted in the technical reports that the Chamber of Commerce and the Municipality of Taranto used to support the candidature of this city for the allocation of the ex-ITALSIDER steel industrial plant (Dattomo, 2011).
[6] Apulia, which is part of the Distretto Idrografico dell'Appennino Meridionale (Southern Apennines Hydrographical District) together with Campania, Basilicata and Calabria and part of Molise (97%), Lazio (21%) and Abruzzo (15%), has a total Utilized Agricultural Area (UAA) representing approximately 36% of the total UAA in the District, while as much as 48% of the irrigated area of the entire district falls within its boundaries (INEA, 2013). Moreover, Apulia hosts half of total water-dependent crop production of the whole District (Distretto Idrografico dell'Appennino Meridionale, 2010).

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Aqueduct seems to be continuously (but unsuccessfully) attempting to catch-up with unattended water and wastewater demands[7]. The irrigation sector is not without problems, as water users consortia are unable to provide enough water to farmers, who largely need to relate on alternative (and often illegal) groundwater pumping, with the final result of worsening the already alarming environmental situation of the water sector.
The author of this paper maintains that the crisis in the availability of water resources in the Apulia region, the current unbalance between demand and supply and the constant need for additional resources, as well as the increasingly compromised quality and quantity of water resources, are not just technical problems. Large infrastructural changes occurred in the water sector in the XX century were somehow the result of (and at the same time one of the determinants of) a deep cultural change, which encompassed the understanding of technology itself and the relationship between man and nature[8]. Starting in the XIX century and even more in the course of the XX century, technology has been increasingly conceived of as a means to overcome natural constraints and to undertake development patterns traditionally considered impossible to be pursued because of restraints in local assets and endowments. While technological change was seen as a sign of freedom, it indeed condemned people to more subtle chains, as people became more and more dependent on natural and cognitive exogenous resources and unable to exit the mainstream pattern of development undertaken. The development approach based on the linearization of cycles and on sectoral specialization has furthermore condemned people to an ever-increasing water demand, which is constantly being unmatched, thus to a fate of water scarcity, which is somehow self-strengthened and self-reinforced.
In this sense technology, conceived of as a means to provide men with a never-ending ability to achieve their aims (Severino, 1988), acted as a powerful shielding mechanism in the fundamental relationship between men and nature (Bevilacqua, 1996). It embodied the dream of Prometheus to free men from the constraints of nature by gifting them the fire stolen from Gods in order to pursue and to build their own ideas outside the constraints imposed by a transcendent deity[9]. But man's continuous attempts to alter the structure of nature to suit himself led "man so far from his origins as to make obsolete the legacy of the customs in which he had grown up and in which he had thought when Nature was his limit […]. This transformation not only affected things, but the relationship that humanity has always acknowledged as impotence in its designs with respect to the insurmountability of the limits." (Galimberti, 1999). After decades of promethean attempts to overcome natural limits, we thus find ourselves abruptly awakened from the positivist dream of risk-free unlimited progress and confronted with the huge environmental problems produced by our actions and with the catastrophic scale of the reckless misuse of our technologies, as shown in the imaginary dialogue between Prometheus and the Eagle made by Bevilacqua (2005).

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[7] In the preface of the new edition of Viterbo's work on Apulia and its aqueduct, Scagliarini states "Today Apulia no longer suffers from thirst, but it is still looking for the security that its territory, poor in natural sources, cannot provide; it is enough just to think of the alarm caused by the decrease in water levels of reservoirs, which today guarantee more than 60% of drinking water for Apulia" (Scagliarini, 2010).
[8] Engineers who pioneered the construction of the Apulian Aqueduct like Camillo Rosalba had graduated from the oldest School of Engineering in Italy (the *Scuola di Applicazione di Ponti e Strade* of the University of Naples), which used to train students to use technology to challenge nature. Thanks to frequent trips abroad and to the excellent school library, engineers were trained on the most important scientific discoveries and technological innovations of that time, so that first Neapolitan engineers could quickly achieve authentic primacies during since the XIX century, from the construction of the first steamboat (1818) to the iron bridges over the Garigliano and the Calore river based on the catenary principles (1832-35), to the Naples-Portici-Castellammare railway line (1839) (Russo, 2010). For a more detailed historical discussion on these matters see also Grassini, 2012
[9] The ancient myth of Prometheus, who, contrary to the will of Zeus, gifted humans with the use of fire, has since ancient times been the metaphor of the dream of men to pursue their own ideas and master nature without being fettered by the constraints imposed by a transcendent deity (Aeschylus, 1995).

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How to take up the challenge to develop a sustainable pattern of natural resources management? This is not only a technical matter. It requires a deep cultural and knowledge change as it needs thinking in a different way to recover a more holistic and multi-sectoral approach to water management and planning.

3 LEARNING FROM THE PAST: MULTI-FUNCTIONAL DIMENSIONS OF WATERSCAPES IN APULIA

Water resources are key features of the landscape in its tangible and intangible aspects. They are part of the natural endowments of a territory; at the same time they are part of the culture of the place and have deep influences on traditional technologies built for their use and socio-economic practices adopted in each territorial context. This is shown in several traditional landscapes of Apulia.

In the Alta Murgia, water is quite abundant in rainfall but there are no surface streams due to the outcropping karstic features of the soil. This steppic plateau has thus traditionally hosted extensive crop-cultivations and livestock. Large farmhouses and rural cisterns to harvest water are typical of this landscape. Rural cistern to harvest water for livestock, the so called *cisternoni rurali*, are quite widespread. They are semi-underground storage tanks, with walls typically coated with tufa, which collected water through sub-soil micro-filtration and natural condensation due to temperature differences (Laureano, 2001). Underground tanks for domestic use are also quite diffuse on the Alta Murgia within the premises of large farmhouses (*Masserie*), which constitute the most typical rural architecture of the area with their large cultivated lands for cereal-crops and livestock. There are also the so-called *neviere*, i.e. small buildings with a square or rectangular base, dug to a depth of 5-6 metres in the ground, roofed with a barrel vault and with access to one of the two sides at ground level. These structures used to collect and accumulate snow during winter so as to augment water resources during summer through melted snow. These water harvesting technologies were all in one with the rural landscape of Alta Murgia and its traditional extensive crop-cultivations and livestock. The large substitution of traditional cultivations with more intensive water-fed ones and the abandonment of most *masserie* put these landscapes – as well as the above mentioned water technologies – at high risks of destruction.

Rural cisterns can also be found in several other areas of the Apulia region. Interesting is the way they are part and parcel of the unique landscape of the terraced gardens in the peri-urban area of Ostuni, where they used to gather water through small cannels made of terracotta or carved out of the rocks and make it available for the irrigation of the gardens where horticultural crops were traditionally grown since the Medieval times. Small dry stone walls on the slopes served at the same time to retain the humidity and to protect soil from erosion. Since the 1970s, the availability of flat lands in the surrounding, with easier access to mechanization techniques for crop cultivation and plenty of water supply from dug wells or other sources, made terraced gardens be mostly abandoned or even encroached with illegal dump sites, excavations and buildings.

Other interesting traditional waterscapes of Apulia are wetlands, although they are almost at risk of extinction as it happens in several other regions. While the extensive land reclamation and channelling efforts carried out in the XIX and XX century in Apulia demonstrate an exclusive understanding of these areas as unproductive and problematic areas, they actually represent high value ecosystems as they often support high concentrations of animals and serve as nurseries for many of these species, furthermore providing a wide range of ecosystem services to humankind, including water filtration, flood control and recreation, as stated in the Ramsar Convention. Yet, in Apulia wetlands constitute only residual landscapes today. Very few wetlands remain of traditional meanders of water streams in Capitanata, with severe consequences on the richness of habitats and landscape quality of riversides.

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These are just few examples of traditional waterscapes in Apulia, which show a multi-functional and multi-sectoral understating of the relationship between water technologies and landscape. How to reverse the fate of abandonment or extinction to which these landscapes seem to be deemed to? This is indeed not an easy task as we have seen how transformations of landscapes in the XX century were the results of deep cultural changes besides socio-economic and technical transitions. The extremely intense period of modernization, which was experienced by Apulia especially after the second world war, brought with it not only mammoth rural development, rapid urbanization, growth of large industrial poles, massive tourism and overexploitation of natural resources. It also led to a deep process of abandonment of a wealth of local knowledge, experiences and skills, in favor of standardization and homogenization of pre-existing material and immaterial culture (Barbanente, 2011). To recover seemingly lost cultural roots and to make them flourish again and grow in innovative ways is not an easy task as it requires time and multifaceted efforts on different levels, both material and immaterial. The examples shown in the next section try to take up this challenge.

4 MULTI-SECTORAL AND MULTI-FUNCTIONAL APPROACHES TO WATER AND LANDSCAPE ANALYSIS AND PLANNING

In the last decade, several pilot experiments as well as scaling-up and demonstration efforts have been taking place in Apulia with the aim to recover and innovate local knowledge and skills.

The rehabilitation project of the terraced gardens in Ostuni is among the pilot experiments carried out at the local level for this scope. The idea to recover these gardens mushroomed from the local community, which proposed the idea to the municipality since the Nineties. But it was only thanks to a farsighted attention to the revival of traditional landscapes, which informed the regional administration in more recent years, that the municipality of Ostuni could obtain funds to refine the project and implement it under the umbrella of urban regeneration activities[10]. This project, which brought to a physical rehabilitation of dry stone walls, cisterns and terraced gardens – which are now being assigned to local associations for their communal use – is being taken further through a project proposal recently submitted for additional funding[11] to connect the town of Ostuni to the monumental olive trees plain through the terraced gardens while supporting the creation of a lively peri-urban community working on horticulture and more traditional activities.

Few other projects are now ongoing for the rehabilitation of rural cisterns in several areas of the region. Special funds have been devoted to this purpose by the regional government, in the attempt to combine support for traditional rural water harvesting techniques with the aim to preserve landscape quality and traditional productive vocations of rural areas[12].

Still at the local level, interesting to note is the artificial creation of some wetlands, among which the largest and the most famous in the region is in Melendugno. In this area, a phytopurification plant has been recently constructed to receive wastewater from the treatment plant of three nearby towns for a total of 41,000 equivalent inhabitants in the summer season. The choice to build the phytopurification plant shows a multi-

[10] For this purpose, the Municipality of Ostuni obtained funding from the Regional Operational Program 2013-2020 (Axis VII, Measure 7.1).

[11] This project has been submitted to a call for project made by the regional government with funding from the Regional Operational Programme 2014-2020 (Axis VI – Environmental Protection and promotion of natural and cultural resources).

[12] On this point fundings are worthwhile to be mentioned, which are provided by the Regional Rural Development Plan 2014-2020 (Misura 4.4) for the rehabilitation of drystone buildings for the collection of rainwater (specifically mentioning rural cisterns and *neviere*) and for the rehabilitation of drystone walls for biodiversity strengthening and hydraulic risk mitigation.

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functional and multi-sectoral approach to water management. On one side, it gives a solution to the wastewater treatment problems of the area, where the effluent of the existing treatment plant were previously discharged on the soil with frequent malfunctioning of the final draining system, mainly due to seasonal variations in the quantity of treated wastewater. On the other side, it strengthens the biodiversity and the ecosystem quality of the area as it creates a priority habitat according to the Habitat Directive (Mediterranean temporary ponds) in between a Mediterranean scrubland and a wooded-pine area. As such it enriches the biodiversity of the area and acts as a nursery for many animal species, including migratory bird population, furthermore ensuring a variety of additional ecosystem services including bioclimatic thermoregulation, groundwater recharge, and recreation activities for local communities. The resulting landscape is thus artificial but it is not the consequence of the simplification of landscapes produced by the linear/sectoral approach of the past; instead, it is the result of a paradigm shift towards a multi-dimensional and multi-sectoral approach to landscape management.

The territorial-landscape plan of the Apulia region, recently approved in 2015, constitutes the most comprehensive effort made in the region to support and scale-up a multi-dimensional and multi-sectoral approach to landscape management. This plan is the first regional plan approved in Italy, which embodies and gives actual implementation to the new approach to landscape valorisation required by the European Landscape Convention (Council of Europe, 2000) and by the new Italian "Cultural Heritage and Landscape Code" (2004). These declarations and pieces of law require to extend landscape policies to the entire territory, encompassing both urban and rural areas, outstanding as well as everyday or degraded landscapes, thus abandoning the traditional focus on the protection of "natural beauties" to adopt a more holistic understanding of landscape (Albrechts et al., 2017). Landscape is considered to be the result of the interaction between local communities and the environment; as such it has tangible as well as intangible features as it is shaped by and contributes to shape values, perception, knowledge, culture, practices and behaviours through territorialisation processes (Magnaghi, 2000; Olwig, 2007).

In particular, the territorial-landscape plan employs multifaceted tools for landscape valorisation, by combining a traditional regulatory approach, aiming at preserving those parts of the landscape protected by national laws or decrees and those considered to be worthwhile to be preserved by the regional government, with a strategic and policy design orientation. As such, it has been conceived of as a unique opportunity to change local culture and practices of territorial transformation in line with a collective effort to re-imagine the territory and to define new priorities for its strategic development, which are being promoted by the regional government since 2005 (Albrechts et al., 2017). The strategic and policy design orientation of the plan is supported by a wide variety of tools, including five "regional territorial projects"[13], a set of guidelines and a wide variety of "integrated experimental projects", aiming at showing, through demonstration activities and pilot projects, the feasibility of the strategy of the plan and the potential for the actual implementation of its re-imaginative vision (Magnaghi, 2011). These try to grasp stories of innovative experiences, like experimentation niches, to show how new ways to protect and enhance territory-landscape values may be consistent with the normative and strategic vision of the plan. Special agreements between the regional government and local public and private actors were made in order to develop these projects, while the European Structural Funds and the Agricultural Fund for Rural Development have been used to finance their design and implementation.

[13] They are: the regional ecologic network, the city-countryside pact, the infrastructural soft mobility system, the integrated valorisation of coastal landscapes, the territorial systems for making cultural and landscape assets accessible.

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One of these integrated experimental projects, which is particularly relevant to show an innovative multi-functional and multi-sectoral approach to natural resources and landscape analysis and planning, is the feasibility study for the ecological corridor of the Cervaro river in the Capitanata area. This study was carried out to test the implementation potentials of one of the five regional territorial projects of the plan, namely the regional ecological network. In this study the use of phytopurification plants is widely suggested as secondary treatment systems to get at the same time an improvement of the water quality of the river, where treated wastewaters are discharged, and the improvement of the biodiversity and landscape quality of the river ecosystem through the creation of wetlands besides the river banks, where multiple meanders and wetlands used to exist before land reclamation and artificial channelling of water streams.

Phytopurification plants as secondary treatment systems are also suggested in the feasibility study for the creation of the multi-functional valorisation park of "*Torri e casali*" (as part of the implementation of another regional territorial project, i.e. the city-countryside pact) in the northern part of the Metropolitan City of Bari. In this study, they are considered an interesting solution to combine improvement in ecosystem quality, reduction of pollution from wastewater discharge, increase in groundwater recharge through the discharge of their effluents in ephemeral karstic creeks (lame), which are abundant in this area. Several other interesting activities showing multi-functional and multi-sectoral approaches to water and rural development analysis and planning could be taken from the pilot implementation of the city-countryside pact, including funding of some projects for the rehabilitation of rural cisterns in the Alta Murgia area[14].

More comprehensive studies to promote multi-functional and multi-sectoral approaches to water management within the framework of the implementation of the city-countryside pact are then carried out by municipalities during the revision of urban plans in accordance with the new territorial-landscape plan. One such an example can be found in the new urban plan of the city of San Severo, where a wide range of solutions combining a multi-functional approach to water management and planning and rural development are suggested, including re-naturalization of rural areas through non productive crops and development of conservative agriculture in hydrological risk prone areas (Leone, 2017).

5 CONCLUDING REMARKS

This paper has highlighted the need to re-discover the complexity of the landscape in its multi-functionality and multi-dimensional features, and has tried to show how destructive tendencies in rural landscapes and natural resources use (above all water resources) may be reversed only through a more complex cultural and knowledge change leading to a different way to understand these resources. For this purpose, a more holistic and multi-sectoral approach to resource management and planning needs to be fostered. This includes the need to re-think of the relationship between urban and rural areas, between ecosystems and production, between man and nature.

In this perspective, the examples shown in the paper seem to be promising. While they try to raise awareness of the immense value of the Apulian landscapes and to dig out from oblivion material and immaterial roots of local culture, they try to find new ways to harmonize that material and immaterial heritage with new economies and productive systems for a different route of local development. The new territorial-landscape plan tries to carry out this tasks by synergically orienting practices for the use and transformation of the territory, as well

[14] One such project was funded e.g. in the municipality of Terlizzi through the Regional Operational Program 2007-2013.

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as local and regional public policies, towards landscape and resource safeguarding, valorization and enhancement (Barbanente, 2011). In so doing it tries to challenge socio-institutional awareness, priorities and cultural frames of a wide range of actors, namely local communities, public administrations, development agencies, firms and professionals involved in the local production of the territory. This work requires time to produce an impact, thus the years to come will be the time to assess the actual achievements obtained by these efforts.

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NATURAL RURAL LANDSCAPE PERCEPTION AND RESTORATIVENESS

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ABSTRACT

There is wide evidence of the positive effects on health and well-being associated with exposure to natural environments. The benefits are related to the perceived restoration from mental fatigue. The literature suggests that the restorativeness depends on the specific characteristics of the setting but also on a characteristic of the subject, called "Connection with Nature". Better understanding these relations, could give important indications to planners, landscape managers and designers. Aim of the research is to investigate the characteristics of the natural rural landscape that influence its preference and perceived restorative quality. Four study areas, in Italy, have been selected, different for degree of protection and wilderness, distance from the nearest metropolitan area (Milan) and landscape characteristics. 435 subjects, approached on-site, accepted to participate and were administered a questionnaire with three scales: (1) the Perceived Restorativeness Scale-11 (PRS-11), with two additional items to assess familiarity and preference; (2) 16 physical and aesthetic attributes; (3) the Connectedness to Nature Scale (CNS).
The data show that the user preference is for harmonious (congruence between its elements), varied and rich in natural elements landscapes, and that the preference is strongly and directly related with the familiarity with the place and its perceived restorative quality.

KEYWORDS

Health and Well-being; Natural Environment's Perception; Preference and Perceived Restorative Quality

1 INTRODUCTION

There is wide evidence of the positive effects on health and well-being associated with exposure to natural environments (for a review see Berto, 2014). The benefits are related to the perceived restoration from mental fatigue, caused by all the situations that during the day call for voluntary directed attention. Mental fatigue implies the inhibition of voluntary attention and the increasing of not controlled distractions. The activation of mechanisms able to restore directed attention capacity is, therefore, fundamental. Direct contact with Nature mainly activates bottom-up involuntary attention so energy does not need to be directed towards suppressing such "distracting" stimuli (Berto et al., 2018). In the Attention Restoration Theory (ART) (Kaplan, 1995), this type of involuntary effortless attention is indicated as "fascination" and the capacity to generate fascination is the most important characteristic of a restorative environment.

The literature suggests that the restorativeness depends on the specific characteristics of the environment but also on a characteristic of the human being, called "Connection with Nature" (Tang et al., 2015). In fact, some studies have shown that many people do not seem to perceive the restorative qualities of nature and, thus, do not generate a preference for such environments (Hartig et al., 2007).

The characteristics of the environment influencing preference can be used as true predictors of it (Coeterier, 1996; Ingegnoli et al., 2016; Purcell & Lamb, 1998; Sevenant & Antrop, 2009; Tveit et al., 2006; Wherrett, 2000; Zyngier et al., 2014;). Better understanding of how people become aware of the positive benefits associated with exposure to natural environments and of the related environmental factors is very useful for planning, design and management of natural landscapes where the main function is tourism-recreation.

The objective of the present study is to verify the key factors of the preference of natural environments and to understand the relationships that exist with the perceived restorativeness and the connection with nature.

2 METHOD AND STUDY AREAS

2.1 METHOD

As people may react differently when they are in a natural environment compared with when simply observe images of that environment (Millar & Millar, 1996), we decided to administer a questionnaire to our subjects during their visit to a natural area. The questionnaire includes the following scales/items:

- age, gender, education, profession and residential location;
- frequency, duration, motivation and "With whom" of the visit;
- a list of 16 physical and aesthetic attributes to assess the setting;
- the Perceived Restorativeness Scale-11 (PRS-11) to assess the setting perceived restorativeness;
- two additional items to assess "familiarity" and "preference";
- the Connectedness to Nature Scale to assess subject's sense of connection to Nature.

The definition of the list of physical and aesthetic attributes to assess the setting has been based on the available literature on the landscape perception (Gruehn & Roth, 2010; Kamičaitytė & Janušaitis, 2004; Sevenant & Antrop, 2009; Tang et al., 2015; Zhang et al., 2013).

We decided to use, first of all, the sensorial and semiotic aesthetic attributes defined by Nasar (1994) that can be effectively used also for natural landscapes (Hidalgo et al., 2006). These attributes are described by 11 items: 1) Vegetation, 2) Visual diversity/richness, 3) Harmony/congruence among different elements, 4)

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Openness and/or spaciousness, 5) Luminosity, 6) Historic or representative place, 7) Cleanliness, 8) Maintenance/upkeep, 9) Place for leisure activities, 10) Meeting place, 11) Novel place.

To these, we added other five items: 12) Accessible, 13) Safe, 14) Quiet and silent, 15) Crowded and 16) Artificial. All the 16 attributes are rated on a 1 to 5-point scale, where 0 = not at all, and 5 = a lot.

The PRS measures an individual's perception of the restorativeness of an environment (Hartig et al., 1997) and is based on the Attention Restoration Theory (Kaplan, 1995). According to ART, what makes an environment "restorative" is the limited need for directed attention (that requires effort) and Nature's capacity to entice involuntary attention (that doesn't require effort) (Berto et al., 2018).

In the present study, we decided to utilize the PRS-11 version (Pasini et al., 2014), with 11 items divided in four restorative factors:

- being-away; a restorative environment provokes a sense of being-away, due to both the change of landscape compared to everyday life and a detachment from commitments and concerns;
- fascination; it is the main component of the regenerative experience. This "involuntary attention" is due to particular landscape components that stimulate curiosity and sensations;
- coherence; it refers to a physically and conceptually ordered environment that fosters its exploration and understanding. The environment is perceived as one with a wider organizational structure;
- scope; it refers to spatial and temporal characteristics of the environment in relation to accessibility, absence of restriction to the movements and the possibility of spending time there.

We added 2 other items to the PRS-11 to investigate familiarity ("this place is familiar to me") and preference ("I like this place"). All these 13 items are rated on a 0 to 10-point scale, where 0 = not at all, 6= rather much, and 10 = completely. The Connectedness to Nature Scale (CNS) (Mayer at al., 2004) measures the extent to which people feel a part of the natural world. It is a positive personality characteristic that improves cognitive capacity, emotional well-being, positive mood, and happiness. People who have greater experiences of the natural environment may express greater affective connection to it than those with less experience Berto et al., 2018). The scale is made up of 14 items and judgments are made on a 1 to 4-point scale, where 1 = never and 4 = always.

A total of 524 subjects older than 18 years of age were approached on-site; of those, 435 (83%) accepted to participate in the research study: 239 males and 196 females, aged 18-85 years (M = 44.17 years, SD = 16.96). The participants were chosen using a convenience sampling procedure.

The same procedure was used for each setting. The on-site administration was conducted during a six-week period from early August to mid-September 2015, on weekdays and weekends and under the same sunny weather condition. Times of day and day of the week were counterbalanced in order not to under or over represent certain types of visitors. Participants were first given a general overview of the study, then they were asked to answer the questionnaire, for approximately 10–15 min. There was only one researcher administering the survey and he remained available during and after the completion of the questionnaire for any additional questions.

Participants' inform consent was obtained and confidentiality was guaranteed.

2.2 STUDY AREAS

The questionnaire has been administered in four study areas (Fig. 1) in Italy (three protected natural areas and an urban park), different for degree of protection and wilderness, distance from the nearest metropolitan area (Milan) and landscape characteristics (Fig. 2).

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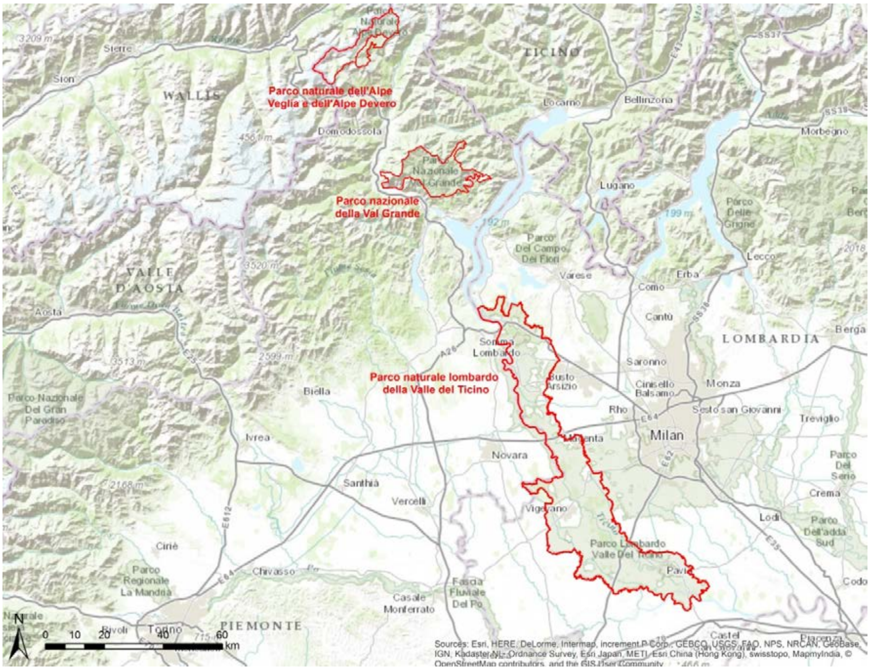

Fig. 1 Map of the four study areas

The three Italian protected natural areas are: Valle del Ticino (a Biosphere Reserve), Val Grande (a National Park) and Alpe Veglia – Alpe Devero (a Natural Park). These parks were selected from a previous research study conducted on 1390 subjects aimed to compare Italian, Austrian and Polish protected areas (Jiricka-Pürrer et al., 2017). Regarding the Italian parks, the study showed that they differed significantly on several items measuring physical-aesthetic appearance. On this basis, we thought plausible to use these settings in our research study. A forth setting was added: Trenno (a peri-urban park in Milano), that can be considered as a sort of control condition, because it is not characterized by high naturalness.

3 RESULTS

3.1 CHARECTERIZATION OF THE RESPONDENTS

The characterization of the respondents shows a certain variability in the different parks, with some important differences. Trenno has more than 35% of the respondents over 65 years and Devero less than 5% (with an average of almost 15%) (Fig. 3). This clearly demonstrate the different typology of these parks and of the people frequenting them. Trenno is a peri-urban park easily accessible (more than 90% of the respondents live in a 10 km radius; see Fig. 4), whilst Devero is far from the city (more than 50% of the respondents live over 100 km; see Fig. 4). The number of people over 65 decreases with the increase of the distance from home. The duration of the visits increases and the frequency of the visits decreases with the distance from home (Fig. 4), indicating that people that go far from home try to maximizing the time.

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Natural Park of Veglia and Devero Alps. It is a Regional Protected Area of 8500 ha, with a typical alpine landscape (meadows and pastures, ponds and streams, small traditional rural villages). It is 160 km far from Milan (2h20' by car).

Val Grande National park. It is a National Protected Area of 14600 ha, characterized by a great wilderness with very different landscapes due to the great morphological and altimetric differences (over 2200 m): narrow torrential valleys covered by dense forests of broadleaf with at higher altitudes alpine meadows and rocky walls. It is 110 km far from Milan (1h50' by car).

Ticino Valley Regional Natural Park. It is a Regional Protected Area of 91800 ha, with a landscape characterized by lowland forests, agricultural areas and by the presence of the Ticino river. Very accessible park, with numerous urban areas included in the protected area boundaries. It is 50 km far from Milan (1h by car)

Trenno Park. It is a peri-urban green area of 59 ha in the north surroundings of Milan, with a fairly homogeneous and typical agricultural landscape characterized by long boulevards of Lombardy Poplars (Populus nigra 'Italica') that divide large lawns used for various sports activities. It is a highly accessible green area, 10 km far from Milan (20' by car).

Fig. 2 Description of the four study areas

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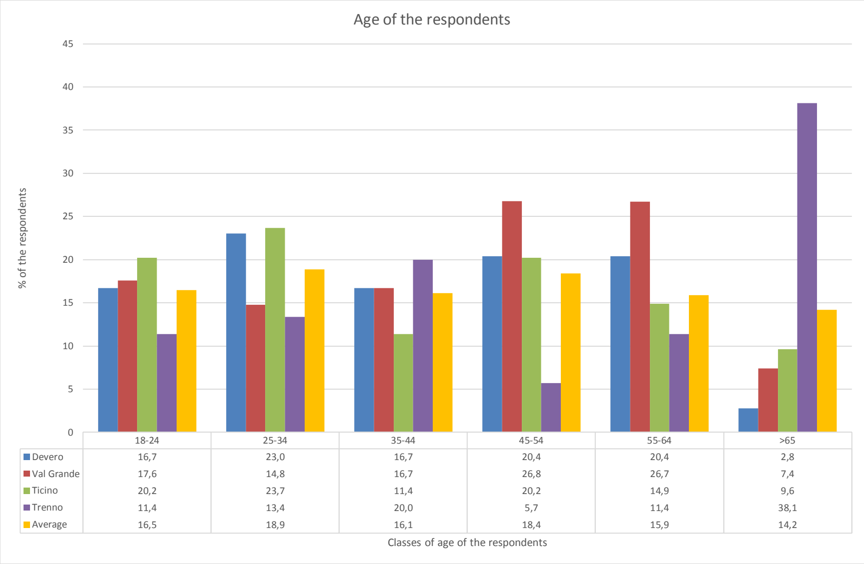

	18-24	25-34	35-44	45-54	55-64	>65
Devero	16,7	23,0	16,7	20,4	20,4	2,8
Val Grande	17,6	14,8	16,7	26,8	26,7	7,4
Ticino	20,2	23,7	11,4	20,2	14,9	9,6
Trenno	11,4	13,4	20,0	5,7	11,4	38,1
Average	16,5	18,9	16,1	18,4	15,9	14,2

Fig. 3 Age of the respondents

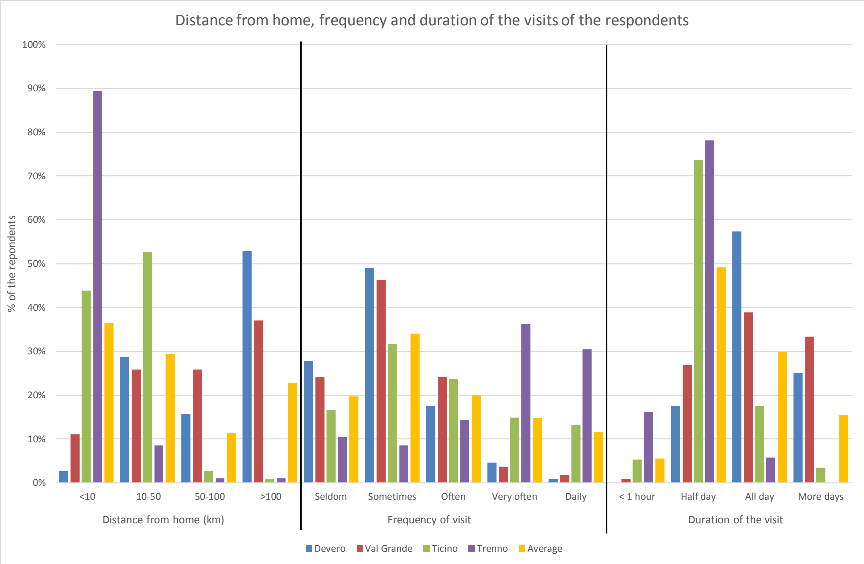

Fig. 4 Some characteristics of the respondents

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3.2 PHYSICAL AND AESTHETIC ATTRIBUTES OF THE STUDY AREAS

The variability of the 16 physical and aesthetic attributes in the four parks is evident (Fig. 5). Nevertheless, for 8 of the 16 attributes Devero and Valgrande present a rating greater than the average. Moreover, it emerges that Ticino has a very low rating for cleanliness and maintenance and Devero is perceived crowded as Trenno.

There is a clear division between attributes inherent to the physical characteristics of the landscape, where Devero is almost always the highest, and "social" attributes, where the major averages are for Trenno. There is also a tendency towards the formation of two groups: the two mountain areas (Devero and Val Grande) often obtain similar results; the same happens to the two plain areas (Ticino and Trenno) which, despite extremely different characteristics, often have very close average scores.

To better understand these results, the 16 physical-aesthetic attributes were grouped into 5 factors, through a Principal Components Analysis (PCA) made with the IBM SPSS Statistics software:

- quiet place, well maintained and managed (attributes: [7] Cleanliness, [8] Maintenance, [13] Safe, and [14] Quiet and silent);
- harmonious place, varied and rich in natural elements (attributes: [1] Vegetation, [2] Visual diversity, [3] Harmony/congruence, [6] Representative place, and [11] Novel place);
- open and bright place (attributes: [4] Openness and [5] Luminosity);
- place that facilitates relaxation and sociality (attributes: [9] Place for leisure activities, [10] Meeting place, and [12] Accessible);
- crowded and artificial place (attributes: [15] Crowded and [16] Artificial).

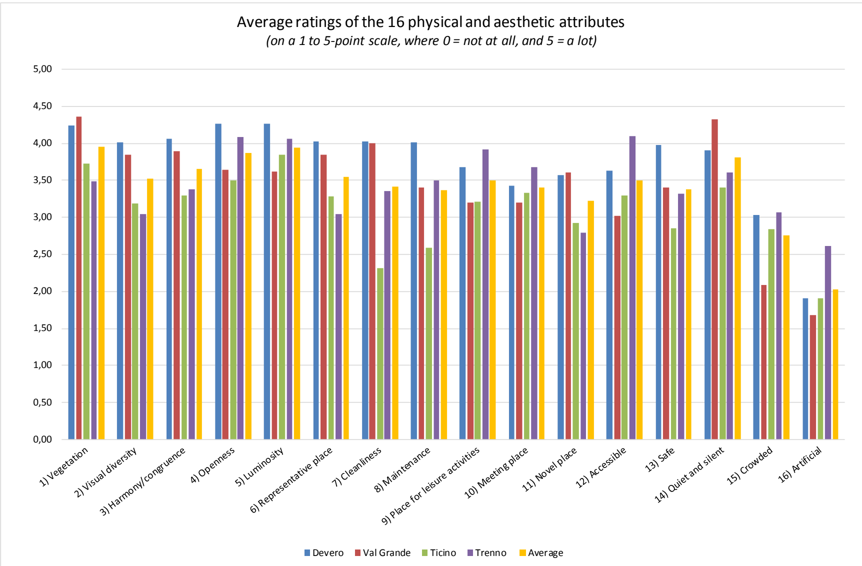

Fig. 5 Ratings of the 16 physical and aesthetic attributes

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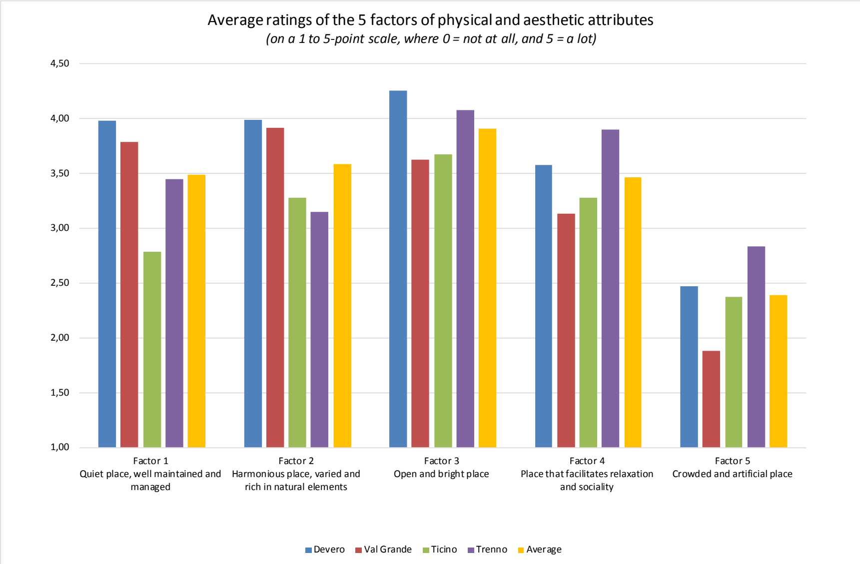

Fig. 6 Ratings of the 5 factors related to physical and aesthetic attributes

3.3 FAMILIARITY, PREFERENCE, PRS AND CNS

Regarding the familiarity, the high score of Trenno (8.45) was expected, due to the fact that the majority of respondents come from very close. On the other hand, the Ticino score (6.89) is much lower than Devero, although respondents know better the area (only 9.65% of the Ticino respondents were the first time they visited the area, compared to 30.56% of Devero).

Regarding the preference, the average scores for Devero (9.08) and Val Grande (8.94) are very high. A little surprisingly, the third best score is that of Trenno (8.02) which exceeds, even quite clearly, Ticino (7.65), although the latter is much less artificial and much more varied and rich in vegetation.

The average PRS scores follow the order of the preference: the two mountain areas show significantly more positive scores (Devero: 7.83, Val Grande: 7.44) compared to Trenno (6.37) and Ticino (6.24). The situation is very similar for regenerative factors ("Being-away" and "Fascination"), while the trend is different for the "Coherence" factor. Devero has a higher average score (7.27) followed by Trenno (6.68) with its extreme homogeneity and linearity. The Ticino average is very low (5.42): probably this is the factor that influences familiarity and preference. Finally, for the last "Scope" factor, linked to the possibility of exploring, to the variety and the curiosity that a landscape can generate, there are clear differences between the different areas (Fig. 7). The CNS, which should be an independent variable linked to the individual, is higher for landscapes with greater naturalness. The respondents in the two mountain areas show an average CNS value (1 to 4-point scale) above the overall average (3.29): Devero 3.41 and Val Grande 3.38. On the other side, respondents in Ticino and Trenno show a lower average value: Ticino 3.26 and Trenno 3.12.

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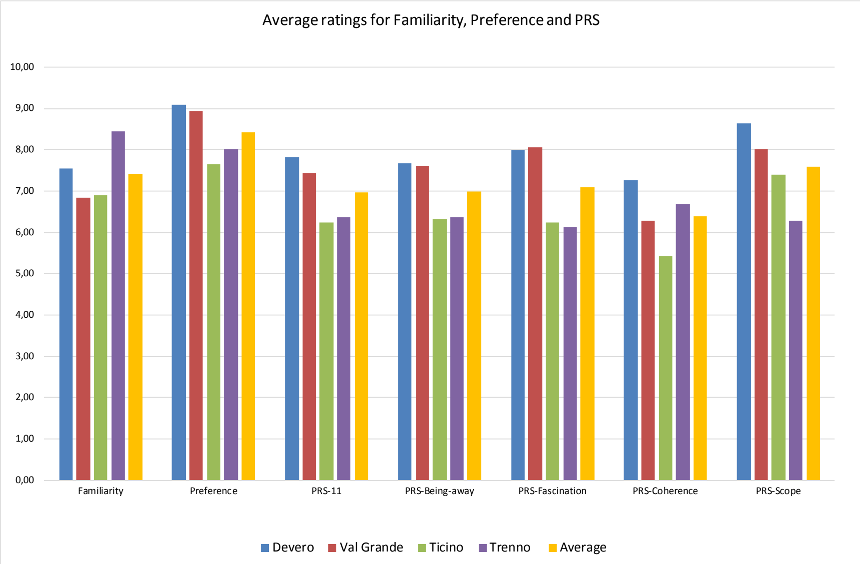

Fig. 7 Ratings for Familiarity, Preference and PRS

4 DISCUSSION

The collected data were analyzed in order to verify the reciprocal influences, through one-way and two-way ANOVA and through Pearson's bivariate correlation. With regard to the characteristics of the respondents, no variable showed important correlations with the preference, except for the visit duration and the distance from home that showed significant correlations at the 0.01 level (respectively 0.321 and 0.211). CNS presents a significant correlation at the 0.01 level both with preference (0.204). and PRS (0.348). The relationship between CNS and PRS is however influenced by the type of landscape. In fact, it can be seen (Tab. 1) that in the least preferred area (Ticino) there is not even a significant correlation, while in the most preferred area (Devero) there is a significant correlation at the 0.01 level much higher than all the other areas (0,509). The connection with nature is the only individual characteristic that is able to significantly influence the PRS, particularly in environments with high landscape quality. Users who have a greater connection with nature can better perceive the restorative capacity of the landscape and consequently benefit from a better attention restoration and stress recovery.

The physical-aesthetic attributes of the landscape play a significant role on the environmental preference. In the different study areas, they correlate differently because the type of use and the characteristics of the landscape vary (Tab. 2).

The preference correlates significantly at the 0.01 level with all factors except the last (as was expected). The first two factors are those that correlate most with preference: it is the tranquility and good management of the area, its diversity and visual and vegetative richness, as well as harmony. Factor 2 has a particularly high correlation (0.551): it is the factor that best embodies the concept of naturalness reported in the literature as a great predictor of preference. These first two factors are certainly excellent predictors of the preference judgment.

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Area		CNS	Preference	Familiarity
Total (all respondents)	PRS	0.348 **	0.691 **	0.340 **
	CNS		0.204 **	0.128 **
	Preference			0.421 **
Devero	PRS	0.501 **	0.615 **	0.532 **
	CNS		0.232 *	0.243 **
	Preference			0.531 **
Val Grande	PRS	0.293 **	0.625 **	0.237 *
	CNS		0.192 *	0.218 **
	Preference			0.296 **
Ticino	PRS	0.173	0.727 **	0.390 **
	CNS		0.145	0.087
	Preference			0.581 **
Trenno (control)	PRS	0.341 **	0.575 **	0.513 **
	CNS		0.153	0.124
	Preference			0.537 **

** = correlation is significant at the 0.01 level (two-tailed)
* = correlation is significant at the 0.05 level (two-tailed)

Tab. 1 Pearson's correlations between CNS, PRS, Preference, and Familiarity scores

The direct influencing effect of familiarity on the preference of the landscape is clearly evident, with a significant correlation at the 0.01 level of 0,421. Familiarity is also correlated with the physical-aesthetic factors of the landscape (Tab. 2), even if not in a high way. All the physical-aesthetic factors of the landscape correlate significantly at the 0.01 level with Familiarity and, except for Factor 5 (Crowded and artificial place), with the PRS. There is a very high correlation (0.620) between PRS and Factor 2 (Harmonious place, varied and rich in natural elements).

Factors	Preference	Familiarity	PRS	CNS
Factor 1 - Quiet place, well maintained and managed	0.353 **	0.119 *	0.408 **	0.085
Factor 2 - Harmonious place, varied and rich in natural elements	0.551 **	0.149 **	0.620 **	0.204 **
Factor 3 - Open and bright place	0.261 **	0.190 **	0.315 **	0.113 *
Factor 4 - Place that facilitates relaxation and sociality	0.142 **	0.194 **	0.235 **	0.079
Factor 5 - Crowded and artificial place	-0.082	0.160 **	-0.003	0.014

** = correlation is significant at the 0.01 level (two-tailed)
* = correlation is significant at the 0.05 level (two-tailed)

Tab. 2 Pearson's correlations between Preference, Familiarity, PRS, CNF and the 5 factors related to physical and aesthetic attributes

It is interesting to analyze not only the PRS, but also its factors to understand what makes a landscape more restorative and what mostly influences the preference (Tab. 3). Our study confirms a very strong correlation between PRS and preference (0.691). Observing the individual regenerative factors of the landscape, stands out the correlation between preference and fascination (0.722), confirming what emerges from the literature that indicates this factor as the most important.

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	PRS-11	PRS Being-away	PRS Fascination	PRS Coherence	PRS Scope
Preference	0.691 **	0.569 **	0.722 **	0.451 **	0.478 **

** = correlation is significant at the 0.01 level (two-tailed)

Tab. 3 Pearson's correlations between Preference, PRS, and the 4 factors describing the perceived restorativeness

5 CONCLUSION

The present study confirmed that the preference is directly influenced by the individual connection with nature (Tang et al., 2015). We found a significant correlation between the two variables, even if not very high (0.204).

In the present study, on the contrary, a significant correlation between preference and familiarity (0.421) emerged; this strong correlation compared to what emerged from the literature is probably due to the methodology used (on-site survey). Familiarity is well correlated with the PRS and, in particular, with its Coherence factor (0.352). In the study areas where the familiarity is greater, the correlation with the PRS becomes important, with values above 0.500. Just the influence of familiarity could explain the higher scores of both PRS and preference of Trenno respect to Ticino.

The study confirms, then, the hypothesis that the areas with greater naturalness are the preferred ones and that they give a greater perceived restorativeness. The significant correlation between PRS and preference (0.691) is very high, confirming that the main restorative factor is fascination (its correlation with the preference is 0.722).

The study also confirms that the connection with nature correlates significantly with PRS (0.348), and that in environments with greater naturalness the link between the two variables is even more intense (in Devero the correlation between CNS and PRS is 0.509, while in Ticino there is not even a significant correlation between the two variables).

Regarding to the physical-aesthetic characteristics of the landscape, the highest significant correlation has been registered between the PRS and the Factor 2 "Harmonious place, varied and rich in natural elements" (0.620) and consequently with the relative landscape attributes (vegetation, visual diversity, harmony/congruence, representative place, and novel place).

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EVALUATING ECOLOGICAL CONNECTIVITY IN CULTIVATED AND URBANIZED AREAS AT LANDSCAPE SCALE

A CASE STUDY IN THE NORTH-EAST PLAIN AREA OF ITALY

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ABSTRACT

Network models, implemented in Geographic information Systems, demonstrated to be very effective for analyzing landscape connectivity and supporting ecological network design and planning. The research aims to develop a framework to assess the ecological connectivity in cultivated and urbanized landscapes with particular consideration on the role of ecological network components. The study area, located in the plain area of Friuli Venezia Giulia (north-east of Italy) is characterized by different agriculture and urban intensities. Here a network modeling approach was developed to incorporate, in a GIS environment, natural and anthropogenic habitats, the barrier effect related to a set of species target (19 flora and fauna species) and effective paths between patches. On this base, a set of graph based indices (Graphab 2.1) were applied. The contribute of species-specific ecological network to the landscape connectivity (probability of connectivity index) was less in case of compact networks, characterized by a low number of smaller nodes and less extended corridors across the study area. Analysis of flow probability of connectivity index allowed to identify a different contribute to connectivity for the different nodes integrating patch characteristics, relations with nearby patches and number of species supported. Larger patches gave a larger contribute to landscape connectivity while small and adjacent nodes were related with a minor contribute. The assessment framework and modelling approach proposed in the research could support local and regional authorities in the definition of natural resource conservation strategies and improve the process of ecological landscape planning.

KEYWORDS

Landscape; Connectivity; Graph Indices; Ecological Network

1 INTRODUCTION

The connectivity concept was introduced by Taylor et al. (1993) as the degree to which the landscape facilitates or impedes species movement among resource patches. In this regard, two are the recognized dimensions: "structural connectivity" and "functional connectivity". Structural connectivity concerns the physical structure of the landscape and the characteristics and the configuration of habitat patches, while functional connectivity is species-oriented and express the behavioural responses of an organism to the various landscape elements (Tischendorf & Fahrig, 2000). Although functional connectivity plays an important role in landscape planning, even though dispersal capacity of species is not considered, the challenge is to integrate functional aspects to identify areas where implement green infrastructures to reconnect existing natural areas. Several modelling approaches and indices have been developed for landscape connectivity assessment (Rayfield et al., 2011). Among these, Graph theory is one of the most frequently used method which can provide a spatial explicit representation of landscape pattern as a set of nodes (habitats) and links (connections between habitats) (Saura & Rubio, 2010). Among Graph-based indices,the Probability of connectivity measures habitat availability integrating both intra- and interpatch connectivity. Intrapatch connectivity describes the connected habitat area within the patch, considering a patch itself as a space where connectivity exist. Interpatch connectivity is the area made available by the connections between different habitat patches (Saura & Pascual-Hortal, 2007). The probability of interpatch connection is usually calculated as a negative function of the effective path (corridor) between two patches. The available paths are not only dependent on Euclidean distances between patches, but thepermeability of matrix (through least cost path) and the indirect connections (through steppingstones) have to be considered as well (Andersson & Bodin, 2009; Manning et al., 2009; Rey Benayas et al., 2008). In this paper we focus on the analysis of the structural connectivity in a cultivated landscape considering the related ecological network model developed in a functional perspective. This is an habitat-species based model (flora and fauna), developed at the local scale in the context of the regional landscape planning process (Sigura et al., 2017). The model is based on a composite multi-species ecological network where the nodes (natural habitats), corridors and stepping stones (links between natural habitats) were obtained for a set of 19 species (fauna species and habitats assumed as proxy for many flora species) to capture favorable conditions for biodiversity. The research aim is to characterize the ecological network considering i) the contribute of the specie-specific network models to the landscape connectivity expressed in the final composite multi-specie ecological network, ii) the contribute of single nodes to the multi-specie ecological network.

2 METHODS

The study area concerns a landscape 298 km^2 wide located in the plane of north-east of Italy (Friuli Venezia Giulia region) (45°48'13.4"N 13°08'11.0"E) (Fig.1). This agricultural landscape is characterized by mixed mosaic of intensively cultivated areas, settlements and semi-natural habitats (e.g. woodlands, meadows, hedgerows, wetlands) which includes 8 Special Area of Conservation (Habitats Directive 92/43/EEC) and other regional protected areas.

Least-cost path analysis and Graph theory were used to obtain specie specific ecological networks then merged into the composite multi-specie network (Fig.1) as expression of the ecological connectivity for the

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entire landscape (Sigura et al., 2017). The multi-specie ecological network includes 1712 ha of nodes and 4252 ha of corridors which occupy respectively 5% and 14% of the entire study area.

The contribute of each specie-specific network model to the multi-specie ecological network connectivity (landscape connectivity) was measured for each specie ecological network by the probability of connectivity index (PC) which measures the probability that two random points in the landscape fall into habitat areas that are interconnected given a set of n habitat patches and the weighted connections (pij) among them (Saura & Pascual-Hortal, 2007):

$$\mathrm{PC} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} a_i a_j p_{ij}^{*}}{A_{\mathrm{L}}^{2}}$$

where

a_i = area of node a_i

a_j = area of node a_j

n = nodes of the network (habitat)

p_{ij}* = maximum interaction probability of all possible paths (direct or indirect) between patches i and j

A_L = total landscape area

PC increases with improved connectivity and has a bounded range of variation from 0 (when no habitat patches are present) to 1 (when all the landscape is occupied by a single habitat).

PCs calculated for each species were aggregated by sum to obtain the total value of probability of connectivity, then used to calculate the relative contribution of each species-specific network model.

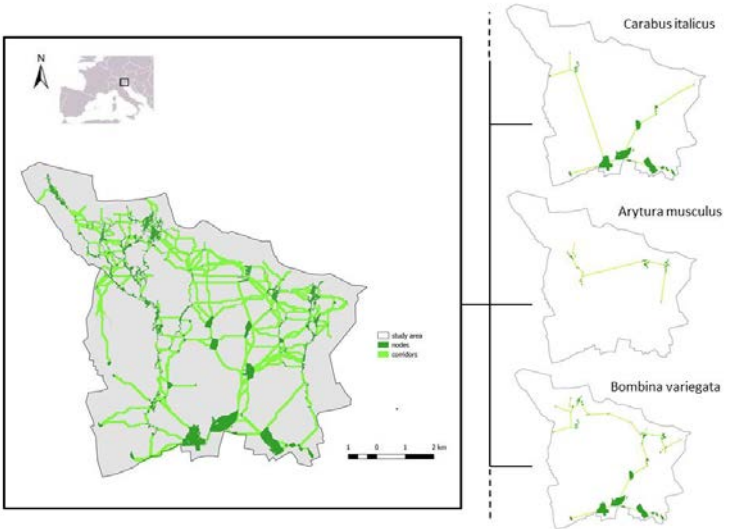

Fig. 1 Study area and elements of the ecological network model (nodes and corridors, stepping stones was not considered in this analysis) obtained by merging 19 fauna species and habitat (proxy for flora) (Tab.1) ecological networks (only three of them are represented in this figure) (Sigura et al., 2017)

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The contribute of the single nodes to the multi-specific network model was measured by the flow probability of connectivity (FPC) which is the sum of products of the focal patch capacity (patch area) with all the other patches, weighted by their interaction probability and divided by the square of the landscape area (Foltête et al., 2012):

$$\text{FPC} = \frac{\sum_{j=1}^{n} a_i a_j p_{ij}^*}{A_L^2}$$

where
a_i = area of node a_i
a_j = area of node a_j
n = nodes of the network (habitat)
p_{ij}* = maximum interaction probability of all possible paths (direct or indirect) between patches i and j
A_L = total landscape area
(range 0 ≥FPC≤ 1)

FPC measures the local contribution of a patch in the overall PC index. The contribution of the specific node was computed for each specie and then aggregated as node attributes of the composite multi-species network. Node flow probability (NFP) is the sum of values calculated for all species (Santini et al., 2016):

$$\text{NFP} = \sum_{j=1}^{n} FPCaj$$

where
n = nodes of the network (habitat)
FPCaj = specie-specific FPC of node a_j
(range 0 ≥NFP≥1)

To consider the importance of the singular node in terms of sustained species, NFP was weighted with the number of associated species, to obtain the so-called weighted node flow probability (WNFP):

$$\text{WNFP} = \text{NFP*n}$$

where
n = number of species substained by the singular node
Graphab 1.2 software (Foltête et al., 2012) was used to compute all graphs and connectivity metrics.

3 RESULTS AND DISCUSSION

The 19 species-specific network models show a different habitat availability, which affects the area occupated by nodes in the entire multi-specie ecological network (Tab. 1).
The contribute of each specie-specific network model to the overall landscape connectivity is very different, varying up to two or three orders of magnitude (Fig. 2). The variation range includes a min of 0.00024 and a max 0.35658 where the average value is 0.10471 (st.dev 0.136). However, the data distribution is shifted to low values because the median value (0.0086) is two or one orders of magnitude lower than the following ones. Specie-specific network models can be substantially divided in two groups where the group characterized by higher values includes all but exclusively species of fauna.

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CODE	DESCRIPTION	N. 2000 CODE	NODE AREA (HA)	NODE AREA (%)
Ary.mus	Arytrura musculus		36	2
BL13	Illyrians Querco-carpineti (Erythronio-Carpinion	91L0	591	35
Bom.var	Bombina variegata		649	38
BU10	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)		171	10
BU5	Tunnel forests of Salix alba and Populus albae)	92A0	190	11
BU7	Ulmus laevis e Ulmus minor, Fraxinus excelsior o Fraxinus angustifolia (Ulmenion minoris)	91F0	88	5
Car.ita	Carabus italicus		591	35
Coe.oed	Coenonympha oedippus		138	8
Emy.orb	Emys orbicularis		225	13
Luc.cer	Lucanus cervus		620	36
PC10	Sub-Mediterranean Arid meadows (Scorzoneretalia villosae)	62A0	173	10
PM1	Low altitude mowing meadows (Alopecurus pratensis, Sanguisorba officinalis)	6510	100	6
PU3	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Eu-Molinion)	6410	109	6
Ran.dal	Rana dalmatina		964	56
Ran.lat	Rana latastei		601	35
Tri.car	Triturus carnifex		216	13
UC11	Calcareous fens with Cladium mariscus and species of the Caricion davallianae	7210	33	2
UP4	Alkaline fens	7230	54	3
Zam.lon	Zamenis longissimus		622	36

Tab. 1 Species and habitat considered for species-specific ecological networks and related nodes availability

PC describes functional connectivity for the landscape as perceived by specie, so in our case study, it is affected by both the ecological characteristics (e.i. habitat preferences) of specie and the extension of considered target habitat for flora species. The analysis of graphs concerning the species ecological networks showed that lower values of PC are associated with compact networks, characterized by a lower number of smaller nodes, and corridors less extended across the study area (Fig. 3) then those associated with higher values of index (Fig. 4). The first group is composed by both habitats whose distribution and consistency are depending on environmental conditions and fauna species characterized by very low mobility. The components of the second group are mainly species which can explore and use a set of different habitats to meet their ecological needs. As pointed out by other authors (Santini et al., 2016), the various species do not equally contribute to the whole landscape connectivity as it is logical if we consider that the species with wider ranges have more influence on the entire network because they are present in more nodes and, consequently, have more chances to explore a given landscape. In this case study a set of fauna species equally sensitive to fragmentation and narrowly-distributed were considered, so the results

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allow to capture ecological behaviors avoiding the problem of the higher influence of the more generalist species (Saura & Rubio, 2010). PC-based metrics shows several important aspects for connectivity assessment like the interpatch connectivity and the intrapatch connectivity. In fact, the latter is dependent of patch area and of both direct and indirect dispersal pathways by accounting for the contribution of intermediate stepping stones that may support movement between patches (Santini et al., 2016; Saura et al., 2007).

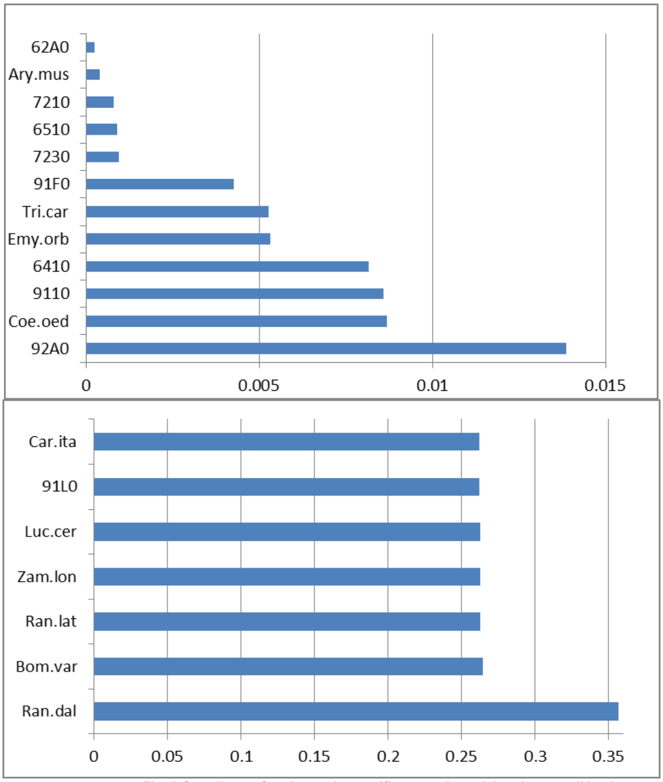

Fig. 2 Contribute of each specie-specific network model to the overall landscape connectivity (PCs)

The contribute of the single nodes to the multi-specific network model was measured by the FPC index, similar to PC, but accounted for the single node. Values calculated for more than 1000 nodes showed a range of values between 1.22e-9 and 0.65. This great variability is confirmed by the high value of standard deviation (0.0346) associated with an average of 0.0022. A wide number of patches involved in the ecological network models for species is related with low values of landscape connectivity as showed by the median value equal to 2.7376 e-9. However, results of cumulated species allow to identify a different contribute to connectivity for the nodes of the ecological network. The spatial distribution of NFP (Fig.5) shows that the north and north-west parts of multi-specie ecological network are characterized by a large number of relatively small and adjacent nodes (Fig.7).

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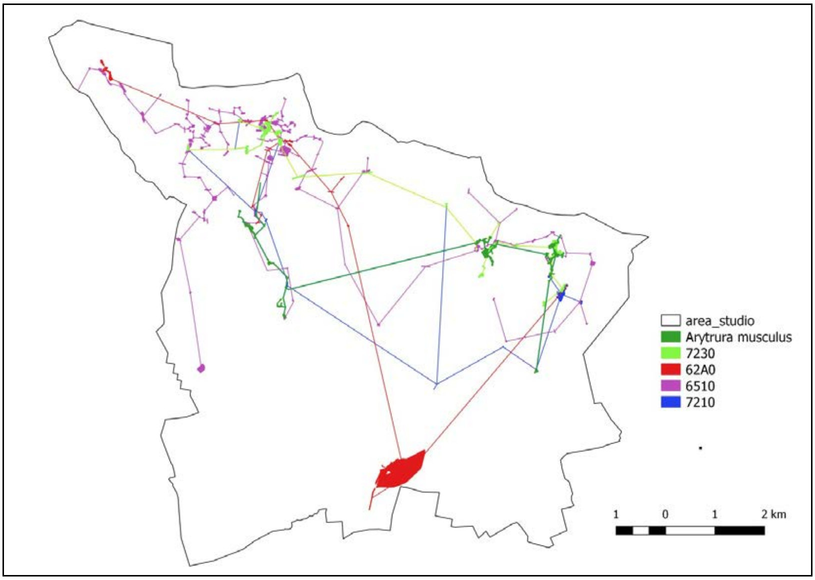

Fig. 3 Analysis of graphs concerning the specie-specific ecological networks associated with lower values of PC (numbers in legend refers to habitat code defined in Natura 2000 habitat classification)

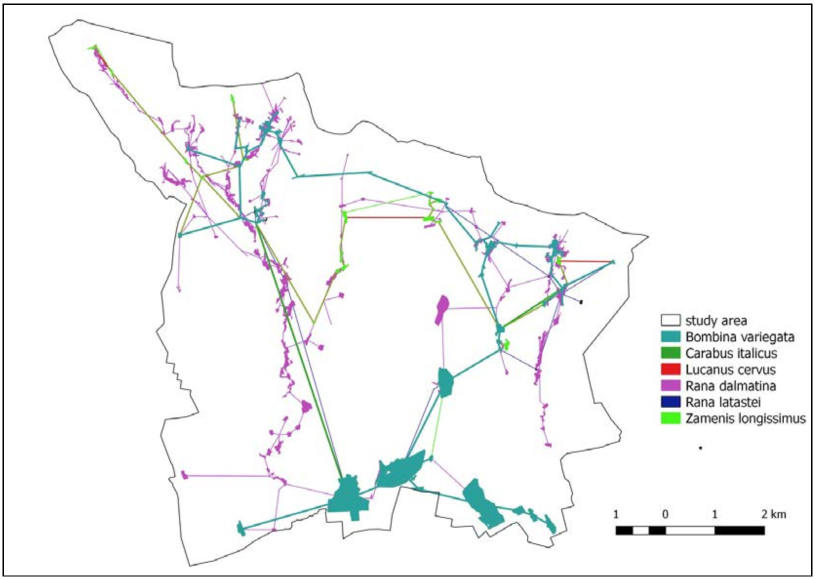

Fig. 4 Analysis of graphs concerning the specie-specific ecological networks associated with higher values of PC (numbers in legend refers to habitat code defined in Natura 2000 habitat classification)

This structural configuration can explain the large amount of low values found because the index assumes low values both when the habitat patches are poorly connected by inter-patch links and when habitat

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patches are well connected but the amount of habitat is low (Reyfield et al., 2011). Larger patches, as expected, show proportionally larger contribute to landscape connectivity.

Comparing these results with the WNFP index ,which considers the node capacity as a function of both the patch area and the number of supported species, a class transition for different nodes was highlighted (Fig.6). This, in particular, is recorded for the largest nodes that are functional for six species in the study area (red cicles in Fig.6), while limited changes are observed for the majority of smaller patches that generally support a single specie or habitat target.

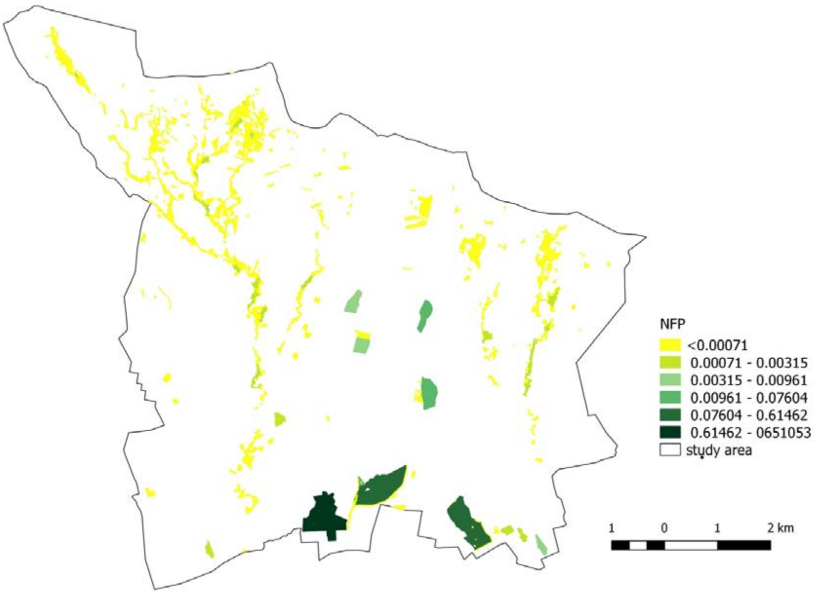

Fig.5 Spatial distribution of NFP index, showing the relative importance of single nodes for the composite multi-specie ecological network considering patch area and relations with the neighboring patches

The application of the connectivity concept in biodiversity conservation and the integration of ecological network in planning process to contrast landscape fragmentation have proven to be very challenging because of their intrinsically specie-specific nature (Boitani et al., 2007). Each species perceives the environment on the base of its own ecological behavior, which drives the response to landscape heterogeneity and matrix resistance. Nevertheless, the multispecies approach is necessary to provide an adequate response to the loss of biodiversity (Albert et al., 2017). The PC index has been used successfully for specie conservation studies and landscape planning (Bodin & Saura, 2010; Carranza et al., 2012) and to predict the effect of infrastructure networks on landscape connectivity (Gurrutxaga et al., 2011; Santini et al., 2016) considering both singular species (Loro et al., 2015; Rayfield et al., 2016) or multi-species (Santini et al., 2016). In this context, our results increase further the knowledge in this last group by measuring the contribution of different species to landscape connectivity but, at the same time, maintaining the information of species level. This represents an advantage for local scale management because it allows to evaluate the effects of different conservation aims throughout specie-specific networks as conservation scenarios.

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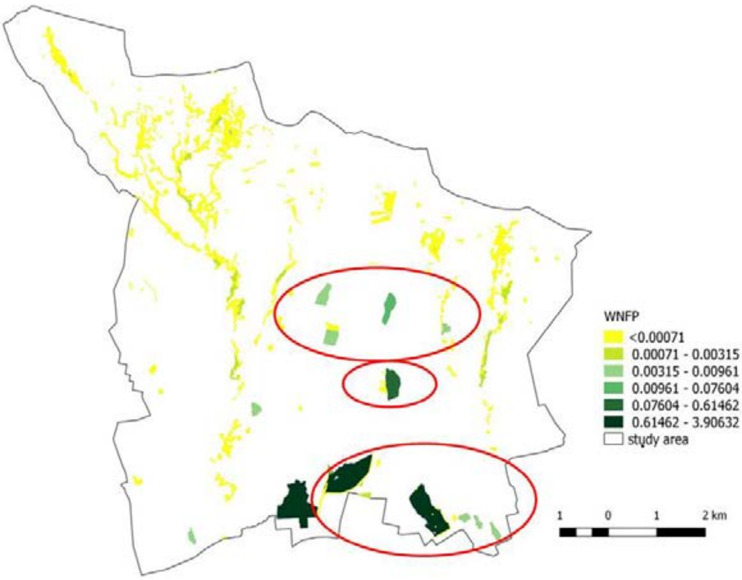

Fig. 6 Spatial distribution of WNFP index, showing the relative importance of single nodes for the composite multi-specie ecological network considering patch area, relations with the neighboring patches and number of species supported

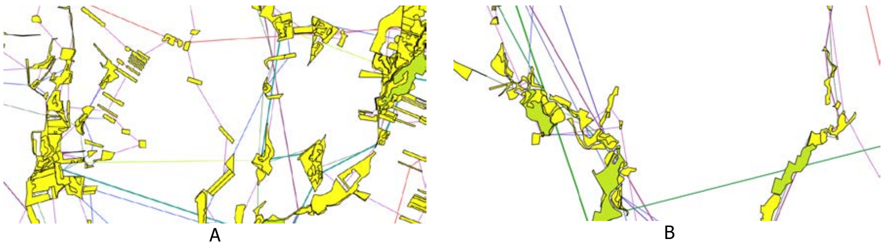

Fig.7 Zoom on the north (A) and north-west (B) portion of the multi-specie ecological network

Also the results about the contribute of each singular node on the overall network can improve the planning process, even though further research should be done on patch capacity parameter whereas the species are influenced by both the structural characteristics of the node and the surrounding habitat types.

Moreover, for a better understanding of the role played by each node in the global connectivity, an iterative analysis of the relative variation of the PC index should be performed before and after the removal of one single element or considering the barrier effect derived from urbanized areas (Saura & Rubio, 2010).

3 CONCLUSIONS

This paper presents a methodological framework for landscape connectivity assessment integrating graph-based models at the landscape scale. A good approximation is provided to identify important areas for natural stock conservation considering a large pool of species. Different metrics of analysis with two kinds of

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viewpoint are explored. The first analysis is based on a species-oriented approach referring to species-specific network models that can be assumed and considered as scenarios in the planning process. The second addresses planning concern by characterizing the availability of functional habitats starting from the capability of specific node weighted by its interaction probability with surroundings nodes. This operational approach and the metrics tested could be useful for decision making in applications where there is a need to assess the impacts of man-made developments on ecological connectivity.

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ANALYSIS OF ZONING PLAN CHANGES IN AN URBAN REGENERATION AREA

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ABSTRACT

Rapidly growing cities after the Industrial Revolution have become incapable to fulfil the needs of the present-day. Furthermore, natural disasters such as earthquakes or floods and low-quality constructions have affected the healthy development of cities in a negative way. It is observed that the countries such as Turkey, where have experienced extensively disasters, have suffered severe physical, financial and moral losses. Thus, urban renewal activities have also gained importance in Turkey after The Gölcük Earthquake (7.6Mw) and The Düzce Earthquake (7.2Mw) in 1999. In Kocaeli which was one of the cities experiencing hard collapses of these earthquakes, the first urban regeneration projects completed in 2009. There is a wide range of urban transformation projects which are completed and continuing in Kocaeli. The examination of the sustainability principles in urban regeneration practices, which became a priority issue due to disaster risks, has also come into prominence. It has become a major subject that urban areas are designed not only to be resistant to disasters but also to fulfil social, economic and ecological criteria.

In this study, healthcare, green, transportation, educational and social areas of the first and second urban regeneration area (approximately 77,0000 sqm) in Kocaeli are examined in terms of basic needs of the city. For this aim, zoning plans pre- and post- project are analysed by transferring to Geographic Information System. The areal changes in the above-mentioned needs are evaluated according to the changing population density and their sufficiencies are compared.

KEYWORDS

Geographic Information Systems; Sustainability; Urban Regeneration; Zoning Plans

1 INTRODUCTION

In the 1950s, the urbanization actions accelerated with the increasing migration from villages to cities in Turkey. The agricultural activities decreased and demand for industrial activities has developed in this period. The increasing population caused unplanned urbanization and the squatters to occur in the cities (Demir & Yılmaz, 2012; Genç, 2014; Güzey, 2016; Kaya, 1989; Sağlam, 2016). For many years, the governments tried to solve the urbanization problems with various construction amnesties. However, it can be said that these construction amnesties and laws did not provided enough benefits to cities and they have even made the problems more unsolvable (Türker Devecigil, 2005; Uzun et al., 2010; Uzun & Şimşek, 2015). Gölcük (7,6 Mw) and Düzce (7,2 Mw) Earthquakes in 1999 have caused a compulsive awakening in the whole country in terms of urbanization. In addition to the urbanization problems that have become totally unsolvable in the industrial cities of Turkey, it has become clear that people and their lives are vulnerable to disasters. As a consequence of all, the urban transformation idea has become a necessity.

Urban regeneration can be defined as a comprehensive integration of the vision and action to solve the many-sided problems of urban areas that are lacking to improve economic, physical, social and environmental conditions (Ercan, 2011; Zheng et al., 2014). Increasing energy consumption and carbon dioxide emissions in cities due to increasing population also accelerates the functional, economic and aesthetic aging process in urban tissue. Along with unplanned settlement, urban sprawl causes the destruction of natural areas and deterioration of the quality of environmental life (Ulubaş Hamurcu & Aysan Buldurur, 2017; Yıldız et al., 2015). Taking all this into consideration, it has become important to plan cities in a sustainable way and to regulate urban transformation activities according to the sustainability criteria.

Sustainability is regularity to economic competitiveness, improved environmental performance, and social integration balance. In this context, the identification of the actors responsible for achieving the objectives set out under the ecological, economic and social components and ensuring continuous supervision and follow-up is crucial for sustainability. Actors who envisaged being involved in the process are the private sector, national, regional and local actors and NGOs (Ulubaş Hamurcu & Aysan Buldurur, 2017).

The sustainability of urban planning is related to the harmonization of urbanization with environmental principles (Hemphill et al., 2004; Noor et al., 2015; Peng et al., 2015; Wheeler, 2004). Today, in this harmonization process, low energy consumption, efficient use of renewable energy resources, use of territory in accordance with ecological principles and people's participation in decision-making processes are the forefront. Industrialization and development movements are in adequate against the constant increase of population, raw materials are consumed rapidly and environmental and economic problems arise. Increasing population living in cities increases demands in terms of infrastructure, transportation, and waste management, and this also puts pressure on planning dynamics and environment (Gölbaşı, 2014).

Zoning plans are designed to fulfill the needs of cities for future according to various usage functions of the land (Demiroğlu & Karakuş, 2012). In other words, the development and orientation of cities according to the zoning plans is the most important element for proper urbanization. However, it was not possible to plan cities that grew rapidly in Turkey after the 1950s properly. The cities developed by their inner dynamics and found their own solutions for those needs of that time. Afterwards, governments have tried to create various solutions through zoning plan arrangements that harmonized with these spontaneous urbanization models. This unplanned urbanization which does not shed light on future was very far from adapting to the requirements of the time. Urban renewal and legislative arrangements provide an opportunity to regulate the old zoning plans and the unplanned urbanization altogether. In this study, the zoning plans which before

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and after the first urban regeneration project of Kocaeli were compared. Firstly, the history of the urbanization of Turkey is briefly mentioned, and then the changes in the land use functions are analyzed in GIS model.

2 URBANIZATION HISTORY OF TURKEY

Urbanization process in Turkey, despite some differences, is similar to other underdeveloped or developing countries. In this respect, for the period before the Republic (1923) until 1950s, it cannot be mentioned about a complete urbanization in Turkey. Until 1950s, agriculture-based economies defined the basis of production relations in the country. However, the Municipal Law No. 1580, one of the first important urbanization laws of the republican history, was issued in 1930 and mandated the development of zoning plans by municipalities for all settlements which population more than 2000 (Resmi Gazete, 1930).

Turkey's population reached approximately from 13 million to 24 million between 1923 and 1955 (Koçak & Terzi, 2012). Despite that, by failing to mention an intense urbanization in this period, it is only seen in the capital city, Ankara which is an administrative center. Urbanization has gained momentum with the industrialization movements supported by foreign capital, which started in the 1950s, and the increased investments in the major cities of the country. The expansion of the road network, the proliferation of transportation facilities in favorable conditions, and the concentration of the main services such as education and health generally in certain urban areas can be considered as other factors accelerating urbanization. The rapid change of social, political and economic relations in the society raised immigration from rural to urban areas. The population migrated from the villages to the cities began to build houses, firstly called squatters, which had no electricity, water, and infrastructure on the public land (Genç, 2014; Uzun & Şimşek, 2015). In order to prevent irregular urbanization, the Law No. 6785 entered into force in 1956 (Resmi Gazete, 1956).

In the period between 1960 1970, it became clear that squatter settlements, which were seen only as a housing problem in previous years, were a socioeconomic problem in the following years. The squatter houses were tried to be improved within legitimizing by laws and amnesties. For this purpose, governments granted title deed to the squatter owners and try to provide infrastructure services such as electricity, water, sewerage. With the Law 775, which was first issued in 1966, the existence of squatters was formally adopted by the state, and official possibilities and rules were introduced (Resmi Gazete, 1966).

The squatter housing problems were tried to be solved with the Law No. 2981 issued in 1984 by granting ownership rights to those who settled illegally in the public areas. By this law which known as the "Construction Amnesty Law" in the public, the owners of the squatter houses were given title allocation documents (Resmi Gazete, 1984).

On 3 May 1985, the new Construction Law No. 3194 entered into force in order to ensure the convenience of the settlements in urban areas to plan, science, health and environmental conditions. With this law, the planning authorities passed the municipalities and extensive planning and development affairs were enforced in the cities (Resmi Gazete, 1985).

1999 Gölcük Earthquake was one of the most important events which revealed the consequences of housing problems, shanty settlement, and irregular urbanization, in the most dramatic way. 18373 people lost their lives and a total of 285211 houses and 42902 business sites were damaged by this earthquake (Wikipedia). After this date, the necessity of transforming and renewing urban areas in a holistic view was held in the foreground. The Law No. 5393, which came into effect in 2005, with the amendment in Article 73, was provided a major expansion for urban transformation in practice (Resmi Gazete, 2005). With the Law No.

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6306 which was issued in 2012, many areas have been declared as risky areas and urban transformation projects have been implemented and continue to be implemented (Resmi Gazete, 2012).

3 STUDY AREA

Kocaeli is located in Marmara Region of Turkey. The population of the city is 1,8 million with a surface area of 3397 sq.km. The city is located on an important road connecting Asia and Europe and has natural harbor; İzmit Gulf which is a busy sea route. Kocaeli with important industrial institutions and advanced economy is one of Turkey's largest industrial cities. Kocaeli, which is located on the North Anatolian Fault, were experienced extreme losses with the Gölcük and Düzce Earthquakes in 1999. The year when the earthquakes were experienced, became an important milestone for the whole country in terms of construction and urbanization. After that date, many laws in terms of urbanization and construction have been enacted to prevent and reduce disaster damages. In this context, various urban renewal projects have accomplished and continue to be achieved in Turkey, especially Kocaeli.

The decision on the practice of the first urban regeneration in Kocaeli was taken in 2005 and the area was expanded with an additional decision in 2006. The urban regeneration area was determined to be about 770000 sqm with the final decision taken in 2010. The construction was mostly completed, and the remaining parts are about to be completed by 2018. Fig. 1 shows the satellite image of the study area in 2007. Fig. 2 shows the view of the area in 2018.

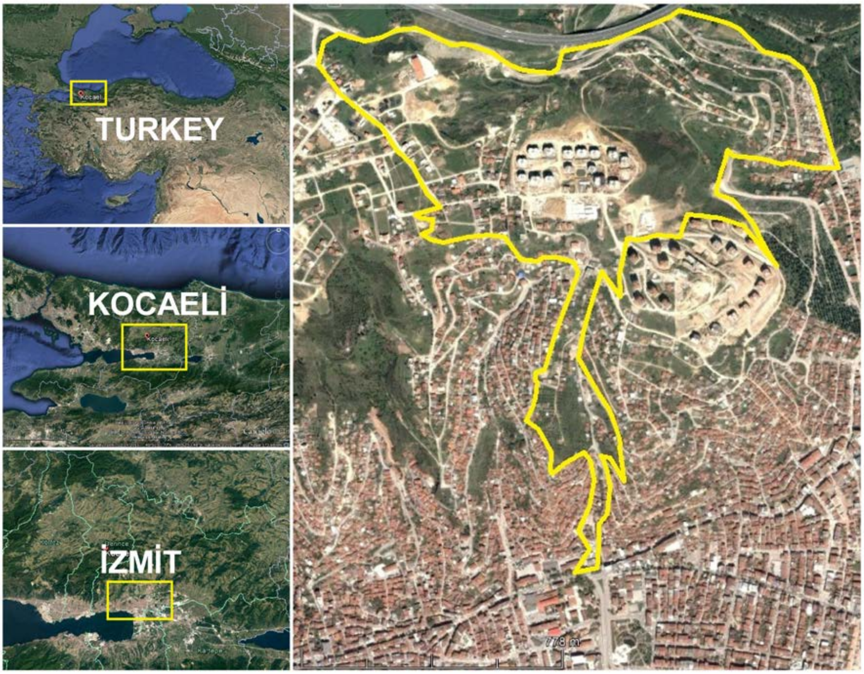

Fig. 1 Study area highlighted with the yellow line, in 2007 (taken from Google Earth)

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The zoning status of the region was generally planned as detached and three-story, before the regeneration. Some buildings were allowed to build two-storey. However, as explained in the previous section, it can be said that due to consecutive construction amnesties and shanty settlement, it was not according to the legal situation of construction in the region. As a result, the area is one of the regions that have been built and then subjected to the legal process in Turkey.

Fig. 2 Study area highlighted with the yellow line, in 2018 (taken from Google Earth)

4 THE GIS MODEL AND THE ANALYZES

In the first step of this study, it is aimed to detect the change of different usage functions in the zoning plans, before and after urban regeneration project. For this aim, the old and new zoning plans are transferred to the geographic information system using the ArcMap 10.1. The land use functions in the plans are divided into 11 different classes as shown in Tab. 1. There was no area for the Cultural Facility, the Technical Infrastructure Facility, and the Trade classes in the old zoning plan. It is seen that these classes are included in the new zoning plan after the urban regeneration. On the other hand, it is determined that the area of approximately 1,2 ha, which was excluded of the zoning (non-zoning area) because of geological reasons in the old zoning plan, was evaluated as road and green area in the new zoning plan. Also in the study, the Green Area class in the old zoning plan contains the total of six sub-classes which are the Children Playground, the Area to be Reforested, the Park, the Green Area, the Cemetery Area and the Highway Area. Similarly, the Green Area class in the new zoning plan contains three sub-classes in the form of the Area to be Reforested, the Green Area and the Highway Area. Fig. 1 shows that there is a highway in the north of

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the urban regeneration area. There are areas that the General Directorate of Highways expropriated and woodland around the highway. For this reason, these areas are included in the Green Area class. The Cemetery Area in the old zoning plan was designated as a reserve area but was not used as a graveyard in those years. Hence, the Cemetery Area is also included in the Green Area class. Fig. 3 and Fig. 4 show the geographical information system and the distribution of land classes formed with old and new zoning plans. A graph of the ratio of land classes to the total size of urban regeneration area is given in Fig. 5. It is seen that the percentage of the Housing Areas is preserved as size when the Tab. 1 and Fig. 5 are examined. There were 729 parcels in the area before the urban regeneration. However, as can be seen from the satellite image of 2007 in Fig. 1, it cannot be said that the area has dense housing. The major reasons for this situation are that the transportation and infrastructure services were not sufficient. Despite that, it is understood that about 4100 buildings could be built in this area according to the old zoning status. According to 2016 statistics, the average population per household is 3,5 in Kocaeli (Tüik, 2016). In this case, it is predicted that the estimated population of the area could reach about 14500 according to the old zoning plan. As a result of the urban regeneration project, a total of 104 buildings were planned in the areas for housing. The construction permission to build has been increased to between 8 and 13 storey in the new zoning plan. When the whole project is completed, the total number of houses will be 4906. In this case, the population in the area can be expected to be around 17000. As a result, although there is a slight decrease in housing areas, the estimated population growth rate in the area is 1,17 and this ratio is predicted not to increase the population excessively.

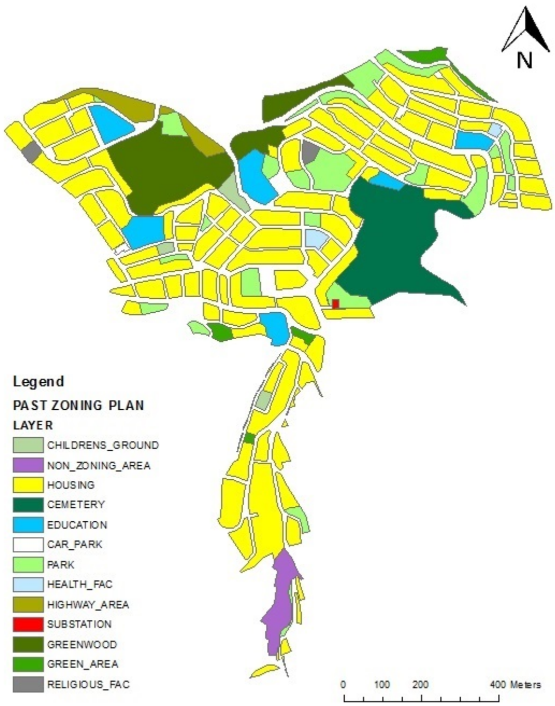

Fig. 3 Distribution of land classes in past zoning plan

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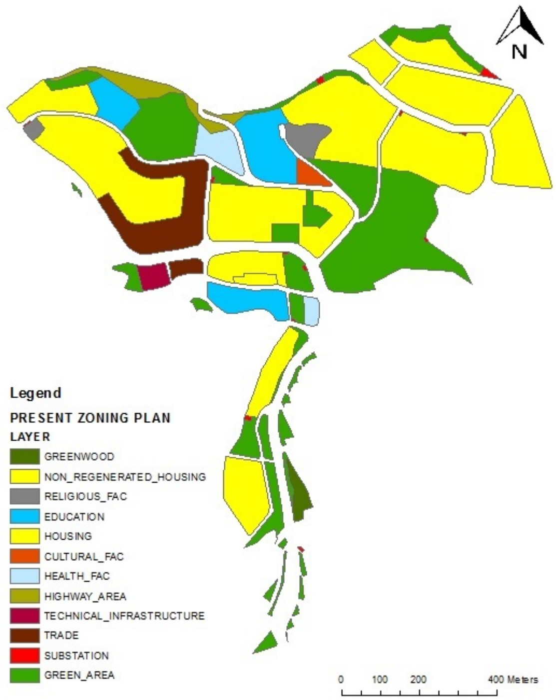

Fig. 4 Distribution of land classes in present zoning plan

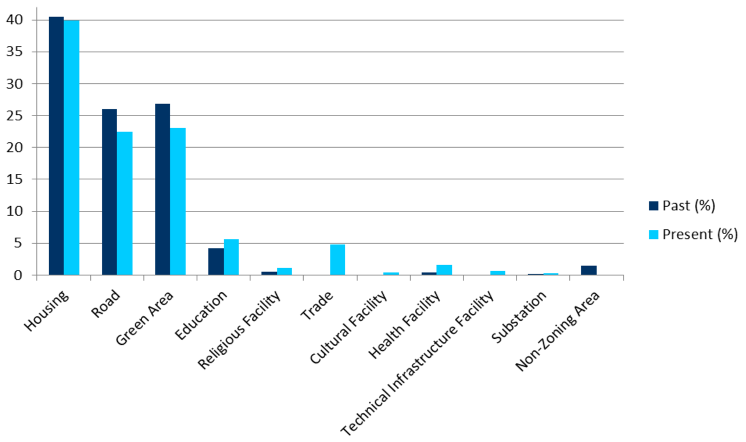

Fig. 5 The ratio of land classes to the size of total urban regeneration area

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LAND FUNCTION	PAST (sq.m.)	PAST (%)	PRESENT (sq.m.)	PRESENT (%)
Housing	311383.93	40.50	306959.45	39.92
Road	199968.54	26.01	172637.47	22.45
Green Area	206318.44	26.83	176877.24	23.00
Education	32169.16	4.18	43633.24	5.67
Religious Facility	3659.52	0.48	8788.68	1.14
Trade	0.00	0.00	37154.60	4.83
Cultural Facility	0.00	0.00	3575.00	0.46
Health Facility	3219.62	0.42	12593.57	1.64
Technical Infrastructure Facility	0.00	0.00	4625.00	0.60
Substation	372.48	0.05	2036.42	0.26
Non-zoning Area	11788.97	1.53	0.00	0.00
TOTAL	768880.67	100.00	768880.67	100.00

Tab. 1 The changes in land use functions

Although the Education areas were 6 parcels before the urban regeneration, there are 3 parcels in the study area after the regeneration. However, it is seen that the Education areas increased 1,36 times. The increase in the area is greater than the possible population increase. In the Religious Facility areas, the number of parcels was not changed at the end of the urban regeneration, while the areas increased 2,40 times. It can be said that this increased rate is higher than the estimated population growth rate. Similarly, while the number of parcels of the Health facility areas remains the same, the increase in the area at the end of urban regeneration is calculated as 3,91 times. In the old zoning plan, the area that determined for the Substation was only 1 parcel; but 12 parcels are determined for the Substation area which there is an increase of 5,47 times in the new zoning plan. Especially, the rates of increase in religious and Healthy facilities and Substation areas were found to be quite high compared to the estimated population growth rate.

When the changes in Green areas in old and new zoning plans were examined, it is determined that green areas decreased 0,86 times after the urban regeneration contrary to other land use functions. Similarly, there is also a 0,86 times decrease in the roads. Interpretation of these changes in land use functions as only increasing and decreasing will be insufficient for urbanization. The positive or negative effects of increasing or decreasing changes in a sustainable city model should be detected with many parameters.

5 RESULTS AND DISSCUSSION

The project, which is discussed in this study is the first urban regeneration project in Kocaeli after the earthquakes in 1999 and it is about to be completed now. After the earthquakes, the growth of the city along the seashore (east-west axis) was decelerated, and the growth was directed to the north, which has more solid ground. For this purpose, 4626 houses were constructed in the northern part of the project area to solve the housing problem after the earthquake (Demirarslan, 2018). In addition, Training Research Hospital of Kocaeli University and the new university campus were built to the north of this area. This planning and structuring raised the problem of transport between the city center and the north of the city. It was aimed to build up a transportation network between the city center and the new settlements in the north. This purpose was provided with Gazenfer Bilge Boulevard, which is an important artery as shown in Fig. 2.

Interpreting the analyzes mentioned in Chapter 4, it can be said that there are significant improvements in the functions of Education, Religious, Cultural, Health Facilities, Trade, Technical Infrastructure, and

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Substation. There is a 0,86 times decrease in the roads, which does not actually mean that transport services are getting worse. The old transport network consisted of narrow streets ranging in width from 6 to 12 meters in the area. Although the area is 2,5 km away from the city center, it was not preferred due to difficulties in transportation and had a low construction before urban regeneration project. A 30-meter wide boulevard and a 20-meter wide street constructed after the regeneration provide access to the north of the city as well as the area. On the other hand, the slope in new boulevard is up to 15% due to topographical difficulties. This situation brings some risks to transportation. As a result, it is not enough to interpret roads only through areal size changes. Similar discussions can be made for a 0,86-times change in green areas. The advantages or disadvantages of the newly designed green areas compared to the old ones should be revealed with many parameters. For example, pros and cons of the change in green areas should be discussed according to flora and fauna or the usage of children, elderly people, young people etc. before and after the regeneration. For this reason, it is a necessity to analyze all this information of the settlement in terms of sustainability and smartness with GIS models. The GIS constitutes the first phase of the study. It is aimed to analyze the sustainability of each of the land use functions with various parameters in the future studies.

From past to present, it is a certain truth that the various zoning and construction amnesties cannot solve the problems of urban sprawl in Turkey and especially in industrial cities such as Kocaeli. For this reason, Law no. 6306 on Transformation of Areas under Disaster Risk which went into effect in 2012, is an important step towards providing more modern and healthy living areas to cities and people although it has caused many controversies. The urban renewal projects in Turkey has been the subject of various discussions for these aspects since then. Displacing people from their habitats, forcing them to live in high-rise buildings, or getting unearned incomes through constructions are the main topics of the discussions(Demirkol & Bereket Baş, 2013). The pros and cons of urban renewal projects should be made analyzeable according to many parameters. The importance of Geographic Information Systems is undeniable for monitoring, analyzing or establishing new models of the effects of spatial changes on the sustainability and smartness processes. The main thing is that not only the reconstruction of habitats but also the changing land functions can be monitored, analyzed and improved.

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ITALIAN METROPOLITAN CITIES

A QUANTITATIVE ANALYSIS AIMED AT THE IMPLEMENTATION OF GOVERNANCE AND INNOVATION POLICIES

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ABSTRACT

The paper analyses the metropolitan system in Italy. The debate on this matter has been going on for 60 years with peaks in specific moments. Aim of the paper, is to verify the adequacy of the system of 15 metropolitan cities in terms of relevance and weight on national and international scale.
The paper begins from the analysis of the backgrounds and of the actual state of the research on the metropolitan issue. A second section analyses the metropolitan cities in Italy in terms of significance on an international scale and in terms of system of rules and functions.
The third part identifies the main sectors influencing metropolitan cities stating it in specific and transversal sectors. The paper deepens the specific sectors using a system of indicators and statistical analyses bringing to the computation of indices of metropolisation. These indexes outline more precisely the belonging of the Italian cities to the metropolitan category confirming the hypothesis that 15 metropolitan cities is a too large sample.

KEYWORDS
Metropolitan Area; Italian Metropolitan Cities; Index of Metropolisation

1 BACKGROUND AND ACTUAL STATE OF THE RESEARCH

With "metropolitan area" we refer to the urban expansion that quickly pours the space surrounding cities. The first extensive attempt to define the metropolitan area notion was the identification, made by the United States Census Bureau, of industrial districts for the Census of Manufactures of 1905 (Berry et al., 1968). The development of the studies in the metropolitan areas has a great push in the period 1960-2000. In US and Europe the researches brought to a deeper knowledge of the topic with significant advances. In 1965 Friedmann and Miller introduced the concept of "urban field" considering the metropolitan area no longer as a physical entity but a network of flows and places formed by people, goods and information. Berry, Goheen and Goldstein (1968) use the travelling for work to define the "commuting fields", namely the combination of the areas of origin of the moves (concentration of housing) and the areas of destination (concentration of labour). In this way, it creates a market of labour focused on a central city. Hall and Hay (Clark, 1982), analyse the Standard Metropolitan Labour Areas (SMLA) and introduce the concept of Metropolitan Economic Labour Area (MELA). The process of building of the Italian metropolitan system started in the 1960s with the researches of Cafiero and Busca (1970), Sforzi (1997), and Marchese (1989).

The study of Cafiero and Busca (1970) had the aim to adjust the territorial and economical dimensions of the metropolitan issue, detecting their evolutionary paths for the following decades. The study did not adopt a specific statistical approach for the determination of the metropolitan areas, given that the logical structure used for the research came from the concept of Standard Metropolitan Area (SMA), introduced in 1949 in US Census (Mazzeo, 2009). Basic indicators were used for the analysis.

In the Italian Census of 1981 the first data collection about commuter's flows was realized. The first research using these data as basis to define the metropolitan state has brought to the definition of 955 local work's systems that are associated in 177 functional work's regions (Sforzi, 1997). In the same period, another line of research proposed to use interaction measurements based on the ability of identifying the relations that form interdependence among simple territorial areas (Chelli et al., 1991; Vitali, 1996). In the last years, new forms of reading of the metropolitan Italian system have come out. Recent studies consider the metropolitan phenomenon as a process extended to a regional dimension (Balducci et al., 2017). The idea that the institutional structures and the territorial areas of narrower extension are inefficient comes from this assumption. Lead concept is the regional character of the new urban era. The hook-up to support this hypothesis is the direct reference to Edward Soja (2006) for which it is not the city to perish, as Friedmann (2002) said, but indeed it enlarges the borders spreading the regional dimension. In this view, it overcomes the metropolis concept by coming to a wider view of urban-regional order.

2 THE METROPOLITAN CITIES IN ITALY. SIGNIFICANCE

The Italian metropolitan areas are identified by a national law, which provides for the institution of ten metropolitan cities on the territory of the previous provinces. The new institutional subject interest the cities of Rome, Milan, Naples, Turin, Genoa, Venice, Bologna, Florence, Bari and Reggio Calabria. The special administrative Regions have identified in their territory other metropolitan cities. Are part of this second list Cagliari in Sardinia, Palermo, Catania, and Messina in Sicily. A last non official entry could be Trieste in Friuli-Venezia Giulia (Gasparini, 2010).

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Fig. 1 Italian Metropolitan Cities

METROPOLITAN CITY (MC)	TERRITORIAL AREA (Sq.Km, 2014)	POPULATION (Nr., 2014)	TOTAL ADDED VALUE AT CURRENT PRICES (Million Euros, 2014)
Milan	1,575.65	3,196,825	150,723.72
Turin	6,827.01	2,291,719	62,304.50
Venice	2,472.91	858,198	23,342.27
Trieste (1)	212.51	236,073	6,649.80
Genoa	1,833.79	862,175	25,578.78
Bologna	3,702.32	1,004,323	34,275.72
Florence	3,513.69	1,012,180	31,906.04
Rome	5,363.28	4,342,046	137,724.55
Neaples	1,178.93	3,118,149	50,230.73
Bari	3,862.88	1,266,379	21,670.74
Reggio Calabria	3,210.37	557,993	6,946.39
Cagliari	4,570.41	561,925	10,945.65
Palermo	5,009.28	1,276,525	19,222.49
Catania	3,573.68	1,116,917	16,553.93
Messina	3,266.12	645,296	9,619.03
Overall MC	*50,172.83*	*22,346,723*	*607,694.34*
Italy	*302,072.84*	*60,795,612*	*1,459,881.00*
% MC respect Italy	*16.61*	*36.76*	*41.63*

Tab. 1 Territorial area, population and total added value of the Metropolitan Cities. Data are related to 2014. (1) Trieste is a proposed metropolitan city. Source: Italian Government, http://dati.italiaitalie.it/opendata.aspx

Italian urban structure has developed with great speed after the Second World War and some of the great cities have extended beyond and across the administrative boundaries. The cases of Milan and Naples are paradigmatic of this situation. Other great cities, as Rome, have used their large territory for to ovecome the expansion without overflow.

In all cases, the urban reality in Italy has become more complex and more and more widen urban agglomerations have risen next to traditional cities (Tab. 1).

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The choice of identifying such a large number of metropolitan cities can be considered entirely political, given that, technically, only a few can be considered so by demographic dimension, economic weight, and international importance.

Another evidence in support of this comes from the analysis of the presence of Italian cities in international studies on metropolitan cities.

Tab. 2 presents the analysis on nine databases managed by official agencies, research centres, and associations of cities and shows the frequency with which Italian metropolitan cities are present. The emerging figure is that there is a group of seven cities (Milan, Rome, Turin, Bologna, Florence, Genoa and Naples) that are present in over half of the databases, while the others are present only in a sample of cases ranging from two to four. It should also be emphasized that all the centers are present in the first two databases. These, however, belong to Eurostat and can be considered an institutional databases for the European cities.

Metro City	01	02	03	04	05	06	07	08	09
Milan	■	■	■	■	■		■	■	■
Turin	■	■	■	■	■		■	■	■
Rome	■	■	■	■	■		■	■	■
Bologna	■	■	■				■	■	
Florence	■	■	■				■		
Genoa	■	■	■				■	■	
Naples	■	■	■	■	■				■
Cagliari	■	■							
Venice	■	■	■						
Bari	■	■	■						
Trieste	■	■					■		
Messina	■	■							
Catania	■	■	■						
Palermo	■	■	■						■
Reggio Calabria	■	■							

Tab. 2 Presence of Italian metropolitan cities in a selection of international studies and internet sites

01. Eurostat. Cities and greater cities. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=urb_cpop1&lang=en. 02. Eurostat. Functional Urban Areas. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=urb_lpop1&lang=en. 03. OECD. http://stats.oecd.org/. Regions and Cities. Metropolitan Areas. 04. United Nations (2016), The World's Cities in 2016. Data booklet. 05. Universidad de Navarra, IESE Business School (2017), IESE Cities in Motion Index. 06. www.metropolis.org (15/03/2018). 07. http://www.lboro.ac.uk/gawc (15/03/2018) (2012), GaWC Data Set 26. 08. http://www.lboro.ac.uk/gawc/datasets/da8_1.html (15/03/2018) European World Cities – Office distribution of global service firms, GAWC Data Set 8. 09. http://www.citymayors.com/statistics/largest-cities-mayors-151.html (2017), Largest cities in the world and their mayors.

Moreover, over half of the Italian metropolitan cities are not representative at international level and are not even present in places where visibility come from voluntary activities. This confirms a marked weakness of the majority of these cities. Few of them, in fact, can claim to be at pace with other international cities, and these few are all located in the Central-Northern part of the country. Therefore, the Southern cities weakness is here visible too.

3 THE METROPOLITAN CITIES IN ITALY. REGULATION

The process of identification of metropolitan cities starts approximately thirty years ago, with the Act nr. 142 of 1990 (Local Autonomies Reform). Because of the lack of take-off of the provisions of 1990, in 2014 was adopted the Act nr. 56 (Fedeli, 2016).

Aim of the national law is to provide these territories with a modern administrative structure, so that they can compete more effectively at national and international level. The new institution represents an answer to the need of governance of complex urban areas (Mazzeo, 2015).

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The reform process of the Italian administrative system based their fundamental motivations on the thematic of simplification. The achievement of this aim seemed to be necessary both to increase the efficiency of the peripheral structures of the State and to reduce its overall weight on the economic and productive system. The formation of metropolitan cities falls within this process.
The source of law of this administrative body is founded on the Constitution and the Act nr. 56 of April 7, 2014, named "Arrangements on metropolitan cities, provinces, unions and mergers of municipalities". The first describes the metropolitan city as an intermediate institution and assigns to it generic statutory, regulative, administrative and financial authorities (Article 114 and followings). The second, by paragraph 2 to 50, defines the structure of the new local authority and assigns to it specific functions.
The territorial extension, one of the main obstacles faced by 1990 previous reform's acts, is imposed as coincident with that of the deleted provinces. With regards to the aspects connected with territorial planning, Act nr. 56, foresees two different tools. The first is the Metropolitan City Strategic Plan (Piano Strategico Triennale – PST), setting guidelines for the performance of the metropolitan functions, also with regards to the implementation of regional functions, delegated or assigned on the basis of specific acts. The PST has a life of three years and may include an annual review. The second tool is the General Territorial Plan (Piano Territoriale Generale – PTG), a plan that specifically deals with communication facilities, service networks, infrastructures under the jurisdiction of the metropolitan community, and constraints and aims to activity and function's practice of the municipalities included in the metropolitan territory. Territorial plans of the Provinces (PTCP) adds functions, as well as the protection and enhancement of the environment.
Territorial planning of metropolitan areas can be considered as a coordination tool connecting territorial assignments that are part of the metropolitan cities with the needs of the communities that they belong to (Gastaldi & Zarino, 2015).

4 SECTORS INFLUENCING METROPOLITAN CITIES

Urban systems are increasingly at the centre of global development processes (Sassen, 2001). Cities are constantly developing in all continents; they are the place where the majority of the Earth's inhabitants live, with a growing tendency that the forecasts believe certain (Mazzeo, 2016; UN, 2015) (Fig. 2). The growing of the conurbations reinforces the notion of metropolitan areas «that are multi-centred urban regions which develop mainly along functional networks, cutting across institutionally defined territorial boundaries» (Kübler et al., 2002). In Europe in particular the process of urbanization has a specific importance, both in terms of population (about 80% of the total is an urban population), and economic. Within this continental space metropolitan areas present more specificity in terms of concentration of assets, innovation and produced wealth (BBSR, 2011).
Considering urban agglomerations of any dimension, it is possible to highlight a number of factors that favour their evolution in the direction of a larger dimension in physical and functional terms, as well as for the role at national and international level. Certainly, among these factors, economy plays a predominant role; but besides that, there are other factors of greater interest to urban studies, like density and territorial use, mobility, quality, governance, and innovation.

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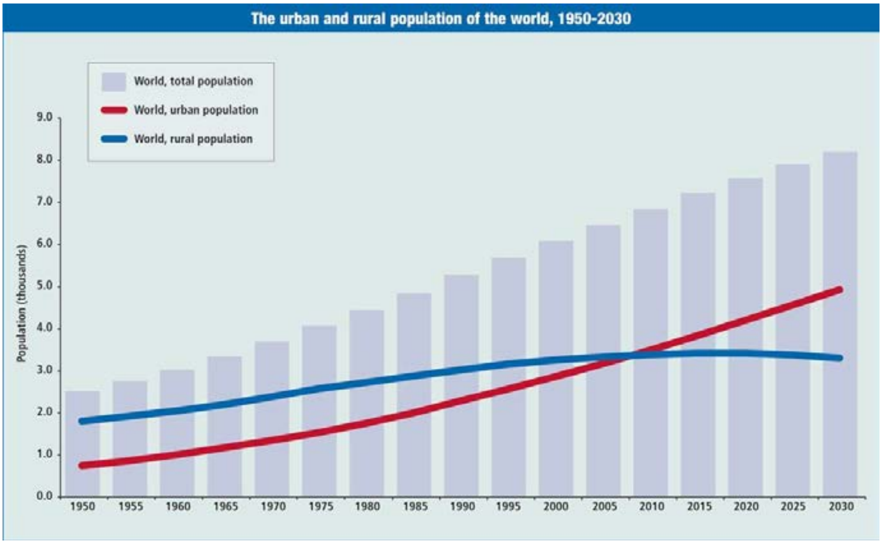

Fig. 2 Urban and rural population. Source: http://www.un.org/esa/population/publications/WUP2005/2005wup.htm

4.1 ECONOMY

Wider urban structures are most successful to fit the actual changings: metropolitan areas and metropolitan regions are among them. For the economists the «large size and rapid recent growth of urban areas are responses to income and employment opportunities provided there. It is but a small step from this observation to the assumption that the conditions of production differ in crucial respects as between urban and non-urban areas and as between urban areas of different size» (Mills, 1967). This is why «the goods production function justifies the existence of the city. The city may be located where the efficiency parameter in the production function for goods is especially favourable» (Mills, 1967).

The economic research bears that the process of agglomeration in metropolitan regions can increase economic and social development, while, on the other hand, fragmentation in metropolitan areas is catastrophic for decision-making. The role of the economic process is fundamental. «Recent concerns with quality of life or with climate change have obscured the basic raison d'être of cities – their productivity, an inclusive productivity that is, to an important extent, a function of their size. Other things being equal, larger metropolitan areas are more productive than smaller ones. Their economies are more resilient and more efficient but, most of all, their advantages stem from their larger, integrated metropolitan labor markets. In large, integrated labor markets, all workers have access to all jobs. Workers are able to find the best jobs and workplaces are able to find the best workers. That is why larger labor markets are more productive than smaller ones» (Shlomo, 2017).

4.2 DENSITY AND TERRITORIAL USES

Density is one of the main indicator on which the debate on urban forms has focused. «Density is a key term which relates the geography of spatial activities to the geometry of places through the built environment» (Batty, 2009).

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This assumption can seem a simplification, but it captures a very important aspect of the phenomenon: the passage from city to non-city is when the density decreases, regardless of the curve's trend characterizing it, the urban functions become more uncommon, and the complexity present in the urban agglomerations falls. Urban planners have tried to define tools to overcome the antinomy between the two conceptual forms of city and non-city. Among them, we can cite the attempt to export the urban features outside the city, with the creation of density and centralities (mobility nodes, commercial poles, leisure infrastructure and more) where they did not exist. However, new extra-urban centralities that, if compared to classic urban ones, are much more simplified in their functionality and structure and they need of an efficient mobility network that is able to connect among them points of the territory increasingly distant but more and more interconnected (Gordon et al., 1997). Density is related to time. The evolution that has led to present urban forms has taken place on different temporal arches from city to city. However we are able to measure it for a frame of hundreds of years. Given this time frame, we can assume that the modern city created over the last hundred years is, necessarily, an unstructured and simplified city, compared to the urban areas that possess a much wider stratification. Connected with the density's variance is the processes of uncontrolled urbanization deriving mainly by the self-referential nature of the market economic system and by its indifference towards the environment. In this process, the city becomes a testing site of the economic theories based on unlimited appropriation of the space (Altshuler, 1977; EEA, 2006).

4.3 MOBILITY

Mobility represents for urban centers the pulsating system along which the goods flow and people move. In cities, mobility is a system involving different modes of transport, with its own characteristics, and dedicated to a specific category of user. The combination and coordination of these modalities determines the efficiency of an urban system (Black, 1995). Mobility and economic systems are closely connected, as are the mobility system and density. Furthermore, mobility represents a field of experimentation of another factor, that is the energy necessary to keep the system functioning (Beretta, 2018). In this sense, mobility in the metropolitan area represents the field of application of advanced technologies of movement and control, with the aim to increase the efficiency of the system and to reduce the environmental impacts of the mobility processes.

4.4 URBAN QUALITY

The issue of the quality of the metropolitan systems conflicts with their extension and with the increasing trouble of creating and maintaining their requirements on the territory (Węziak-Białowolska, 2016). It is extremely difficult to think of the metropolitan territories in terms of beauty and quality of space, because the urbanization process has generally created new, mediocre areas, with isolated elements of quality. It follows that living and working in a metropolitan space means living and working in a space that provides poor satisfactions from the point of view of psychological well-being. Usually, we link the quality to the structured urban areas and the usefulness to the metropolitan spaces devoted to production. Quality and utility are connected to each other and generally this relationship is of reverse order, so to a greater utility links a lower quality. This in a classic vision. The most recent studies highlight the «critical links between environmental sustainability, quality of life and the future success of cities expressed in terms of social and economic as well as environmental factors» (EEA, 2009, 9). The study of EEA quotes a well-known report on the economics of climate change, the Stern Report (Stern, 2006), arguing «that the real economic costs of unsustainable living and further climate change are much higher than the cost of investments in climate change mitigation and

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adaptation. The shift to more sustainable lifestyles is therefore not simply a matter of putting the environment first but also about recognising that the economic viability of cities must built on a sustainable basis of long-term social, environmental and economic stability and equity» (EEA, 2009).

4.5 METROPOLITAN GOVERNANCE

Generally, if the physical size and the number of inhabitants are the main factors linked to a city assuming the name of "metropolis", the definition of "metropolitan area" is associated with the functional relationships created at the local level, the provision of infrastructure and the size of activities' system, mostly the highly specialized (Salet et al., 2003). For this reason, metropolitan areas are territorial systems which enjoy of particular attention at international level, so to reach the constitution of ad hoc administrative structures, provided with operational both managerial and strategic capabilities. For Hamilton et al. (2004), even though metropolitan administration is the key of process, its probability of success depends on the vertical relations established on a central and local level (just think of financial flows from the centre) and on the horizontal relations between the municipalities belonging to a metropolitan region.

Mentions to the "problem of metropolitan government" are often made in characterizing the issues which are supposed to arise in metropolitan regions. From this point of view, the citizens of a metropolitan region are not provided with the tools of government to deal directly with the range of problems. In addition, there is a multiplicity of national and regional individuals, cities, and special public bodies acting within a metropolitan region. We can assume that «the multiplicity of political units in a metropolitan area is essentially a pathological phenomenon. The diagnosis asserts that there are too many governments and not enough government. The symptoms are described as "duplication of functions" and "overlapping jurisdictions"» (Ostrom et al., 1961). From a managing point of view, the presence of autonomous units of government are considered incapable to resolve the metropolitan problems, thanks to their organization that Ostrom calls of "crazy-quilt pattern". The solution is the «reorganization into larger units to provide "a general metropolitan framework" for gathering up the various functions of government. A political system with a single dominant center for making decisions is viewed as the ideal model for the organization of metropolitan government» (Ostrom et al., cit.).

4.6 INNOVATION

The term innovation can represent an opportunity or a blunder. With it we represent different levels of actions. Innovation can mean to change an administrative process by reducing the necessary steps; can mean using a technology that makes it possible to reduce the time required to carry out an action; can mean using an energy source that does not produce emissions or that transforms centralized production into a capillary production also usable as an exchange currency (Mazzeo, 2013). Innovation in the end modifies the perception and characteristics of reality, bringing it to a different level and condition from the previous one. The economic studies have always considered the city as the most important driver of the dissemination of innovation thanks to the high concentration of population (and brains) present in it (Boserup, 1981). If we want to state the main characteristics of the cities we can state that «1. cities have emerged as the world's economic platforms for production, innovation and trade; 2. urban areas offer significant opportunities for both formal and informal employment, generating a sizeable share of new private sector jobs; 3. urbanization has helped millions escape poverty through increased productivity, employment opportunities, improved quality of life and large-scale investment in infrastructure and services; 4. the transformative power of urbanization has, in part, been facilitated by the rapid deployment of Information and Communications Technology» (UN Habitat, 2016, 27).

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5 APPLICATION TO ITALIAN STATE. MATERIALS/METHODS

The governance of metropolitan systems represents a test field about the application of innovations to the city functioning. It is strictly connected with concepts as international competition or with the relevance of the cities in the institutional structure of a nation.

Economic system, density, territorial use, mobility, and urban quality can be considered as the main specific factors (or sectors) connected to the functioning of the metropolitan areas. Above these sectors there are two transversal areas influencing positively or negatively all the metropolitan systems. The first is the governance that is a way to infill in these territories efficient elements for their overall evolution. The governance is a transversal area connecting the previous four (more specified and sectoral) with their decisions and choices and organizing them with the aim to favour the functioning of the system.

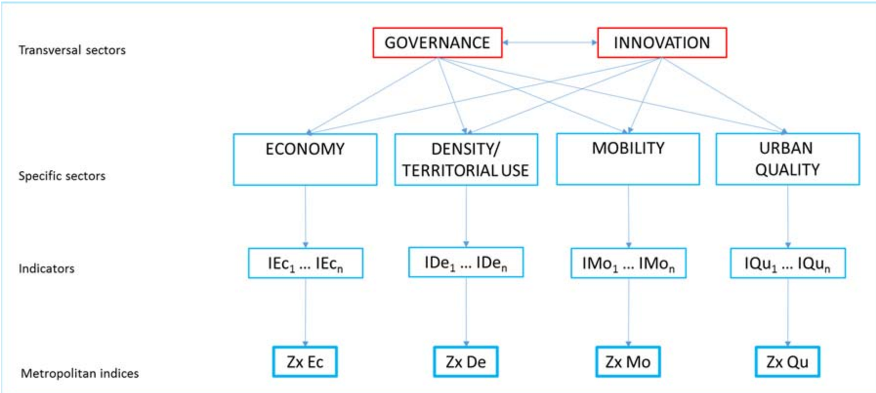

Fig. 3 Logical structure for the building of the metropolitan indexes

The second transversal sector is innovation. Noteworthy are the technological, organizational and system innovations that can give a strong hand to the government in achieving its objectives. Among innovation, particularly interesting are the energetic matters that play a role of fundamental importance for the future of the metropolitan organisations and for their efficiency.

Starting from the partition of the sectors in specific and transversal, the paper (1) associates a system of indicators to the specific sectors, (2) defines a data processing and (3) extracts synthetic indexes explaining a series of phenomena connected with the metropolitan areas (Fig. 3). The quantitative data that associates the indexes to metropolitan cities determines the level of strength or criticality. The identification of strengths and weaknesses makes it possible to build government policies aimed to strengthen the former and develop the latter. The function used to calculate the synthetic indexes, in an ideal model, should comply with certain desirable properties to take into consideration when a technique of calculation methodology is chosen (IESE, 2007):

- existence of the indicator and, eventually, of partial indicators;
- monotony regarding the variations in the partial components. A variation in any of the partial indicators means that the synthetic indicator must have a variation in the same direction;

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- unicity of the partial components; in a given situation, the synthetic indicator yields a single result, for which the property of invariability must be fulfilled;
- homogeneity of grade one of the function, so that, by multiplying each partial indicator by a constant, the synthetic indicator is multiplied by that same constant;
- transitivity;
- completeness in the use of the information provided by the partial indicators, avoiding the duplication of information.

5.1 CALCULATION: INDEXES OF METROPOLISATION

The logic process of the production of synthetic indexes starts from the choice of quantitative data.

In this application the indicators are mainly extracted by the data-base dati.italiaitalie.it of the Italian Government, containing a system of about 300 indicators coming by several sources (Istat, Infocamere, Tagliacarne, and so on), organized in themes going from work to environment, from mobility to innovation. This database is updated to 2015, with the more recent data dated 2014. From this database we extract 36 indicators, each of which is associated to one of the 4 sectors.

The second passage is the use of a statistic structure that brings to the building of an index for each sector and for each metropolitan city defining the performance of a city to a specific system of indicators.

In the construction of the indexes, a double analytical path can be used. The first way considers only the basic indicators, the second assigns to each of them a weight that could change their relative relevance. In this second case, one indicator can assume an emphasis more or less appreciable derived by qualitative considerations or by the aim of the research. In this application the first method is applied because the number of indicators makes it difficult to define the weight of each element in relation to the others.

The data-set is composed of 36 indicators. Each of which is associated with a sector. In particular, 14 for economy, 6 for density/territorial use, 6 for mobility and 10 for quality (See Annex 1).

To compare the different indicators, the first passage is the normalization of the data, using the Z-score technique:

$$Z_x = \left(\frac{x - \bar{x}}{\sigma_x}\right) \qquad (1)$$

where Z_x is the normalized value of the variable x, $\bar{x}$ is the average value for the whole test sample (N is formed by the 15 metropolitan cities), and σ_x the standard deviation of the variable x of a population of N elements, defined as:

$$\sigma_x = \sqrt{\frac{\sum_{i=1}^{N}(x-\bar{x})^2}{N}} \qquad (2)$$

Applying the formulas to the four groups of sectors, the original data are normalized making it possible a quantitative comparison based no more on a matrix 15 x 1 (the single indicator) but on a matrix 15 x n formed by the 15 metropolitan cities and the n indictors of one of the sectors.

Tab. form 3 to 6 report the results of the application of the equations (1) on the basic data.

For intrinsic construction, if Z-score is positive, the corresponding raw score is greater than the mean, if it is negative, the corresponding raw score is lower than the mean. Furthermore, the absolute value of the Z-score defines how many standard deviations the element is away from the mean (in positive and in negative). For each sector, it is possible to sum the Z-values and to use this value as sector metropolitan index. This sector index defines an order of the 15 cases based on the performances of the city measured by the indicators.

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A second passage, from the four previous Tab. 3 - 6, foresees the computation of the average of the values of Z-score, as reported in Tab. 8 and in Fig. 4.

ECONOMY	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Bari	-0,43	-0,78	-0,79	-0,37	-0,63	-0,24	-0,05	-0,38	-0,36	-0,15	-0,20	-0,52	-0,53	0,15
Bologna	-0,14	1,03	0,62	-0,02	0,59	0,01	0,63	0,46	-0,19	0,50	0,22	1,34	0,11	-0,37
Cagliari	-0,68	-0,53	-0,81	-0,57	-0,40	-0,52	-0,59	-0,35	-0,10	2,59	-0,69	-0,67	0,43	-0,73
Catania	-0,55	-1,02	-0,79	-0,53	-1,07	-0,50	-0,48	-0,69	-0,57	-1,04	-0,63	-0,67	-0,72	-0,30
Florence	-0,20	0,75	0,26	-0,17	1,43	-0,13	-0,25	0,25	-0,30	0,22	1,43	0,13	-0,49	-0,13
Genoa	-0,34	0,55	0,72	-0,48	0,95	-0,35	-0,42	-0,34	-0,36	-0,29	-0,47	-0,04	-0,30	-0,61
Messina	-0,71	-1,01	-0,99	-0,60	-0,77	-0,70	-0,65	-0,68	-0,32	0,72	-0,67	-0,67	-0,50	-0,74
Milan	2,54	2,41	2,89	3,16	1,80	3,09	3,25	3,13	3,53	0,86	3,14	2,93	2,46	3,14
Naples	0,22	-0,88	-0,32	-0,18	-0,04	-0,09	-0,14	-0,27	-0,21	-0,69	-0,06	-0,49	-0,55	0,69
Palermo	-0,49	-1,00	-0,49	-0,54	-1,81	-0,63	-0,63	-0,77	-0,61	-1,39	-0,69	-0,66	-0,74	-0,74
Reggio Cal.	-0,77	-1,27	-1,39	-0,62	-0,51	-0,76	-0,67	-0,78	-0,64	-1,36	-0,71	-0,69	-0,73	-0,75
Rome	2,24	0,77	0,68	1,38	0,57	1,20	0,06	0,01	0,58	-0,86	-0,27	-0,41	0,27	0,81
Turin	0,50	0,29	0,08	0,66	1,04	0,96	1,09	1,36	0,42	0,62	0,23	1,17	2,32	0,71
Trieste	-0,78	0,40	0,27	-0,61	-1,09	-0,75	-0,73	-0,59	-0,55	0,38	-0,60	-0,36	-0,62	-0,62
Venice	-0,40	0,29	0,05	-0,50	-0,06	-0,60	-0,45	-0,36	-0,32	-0,11	-0,04	-0,38	-0,44	-0,53

Tab. 3 Z-score calculated for the sector “Economy”. Matrix 15*14 = 210 values. 69 positive values (32,86%)

DENSITY AND TERRITORIAL USE	01	02	03	04	05	06
Bari	-0,69	-1,08	-0,67	-0,54	-0,73	-0,33
Bologna	0,50	1,06	1,58	-0,53	-0,89	-0,42
Cagliari	-0,01	-1,21	-0,15	-0,82	-1,20	-0,96
Catania	-1,13	-1,16	-0,53	-0,53	0,26	-0,54
Florence	0,57	1,31	1,26	-0,57	-0,41	-0,50
Genoa	1,88	0,29	-0,18	-0,07	-1,12	-0,47
Messina	0,00	-0,77	-0,78	-0,61	0,34	-0,73
Milan	-0,13	1,63	1,09	2,21	1,48	2,10
Naples	-1,69	-0,99	-1,59	2,35	0,72	2,33
Palermo	-0,93	-1,17	-0,74	-0,59	0,79	-0,78
Reggio Calabria	-0,68	-0,55	-1,70	-0,72	0,23	-0,78
Rome	-0,49	1,20	0,77	0,15	1,39	0,05
Turin	0,39	0,60	0,28	-0,44	1,45	1,15
Trieste	2,11	0,29	1,30	1,07	-1,68	-0,32
Venice	0,30	0,55	0,07	-0,37	-0,63	0,19

Tab. 4 Z-score calculated for the sector “Density and territorial use”. Matrix 15*6 = 90 values. 39 positive values (43,33%)

MOBILITY	01	02	03	04	05	06
Bari	-0,40	-0,36	-0,41	-0,94	-0,46	-0,66
Bologna	-0,08	-0,08	0,04	0,15	-1,36	-0,23
Cagliari	-0,46	-0,41	-0,56	0,14	-0,33	-1,06
Catania	-0,12	-0,01	-0,53	-0,98	-0,16	-0,77
Florence	-0,45	-0,53	-0,10	-0,01	1,20	0,10
Genoa	-0,61	-0,64	-0,70	0,01	0,29	0,34
Messina	-0,80	-0,74	-0,82	-1,03	-1,37	-0,74
Milan	2,18	1,80	2,66	1,35	1,72	-0,04
Naples	-0,05	-0,05	0,64	-0,60	-1,38	0,02
Palermo	-0,34	-0,28	-0,72	-1,04	0,12	-0,70
Reggio Calabria	-0,75	-0,71	-0,88	-1,04	-1,40	-0,53
Rome	2,73	3,00	1,15	1,08	0,91	0,68
Turin	-0,32	-0,41	1,39	-0,10	0,79	-0,62
Trieste	-0,65	-0,68	-0,99	0,49	0,52	3,00
Venice	0,12	0,09	-0,16	2,51	0,91	1,23

Tab. 5 Z-score calculated for the sector “Mobility”. Matrix 15*6 = 90 values. 32 positive values (35,55%)

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QUALITY	01	02	03	04	05	06	07	08	09	10
Bari	-0,62	-0,70	-0,66	-0,48	-0,54	-0,62	-0,12	-1,19	0,40	-0,31
Bologna	-0,44	-0,52	-0,53	-0,50	-0,39	-0,45	-0,05	1,10	0,78	0,83
Cagliari	-0,42	-0,59	-0,58	-0,48	-0,77	-0,49	-0,95	0,79	0,71	0,82
Catania	-0,60	-0,68	-0,61	-0,51	-0,57	-0,78	0,18	-0,87	-1,29	-1,37
Florence	0,11	0,44	0,57	0,88	1,55	2,56	-0,92	1,00	0,90	0,88
Genoa	-0,46	-0,51	-0,50	-0,50	0,13	-0,02	0,85	0,13	0,68	-0,09
Messina	-0,33	-0,49	-0,42	-0,51	-0,72	-0,75	-0,49	-1,15	-1,86	-1,59
Milan	0,03	0,56	0,31	-0,36	0,17	-0,19	1,63	1,34	0,77	1,32
Naples	0,03	0,33	0,12	0,77	0,34	0,03	0,28	-1,15	-0,29	0,31
Palermo	-0,45	-0,55	-0,48	-0,51	-0,84	-0,85	-0,79	-1,01	-1,40	-1,82
Reggio Calabria	-0,67	-0,80	-0,71	-0,45	-1,31	-1,02	-1,88	-1,58	-1,28	-0,97
Rome	1,54	1,84	1,99	3,37	1,34	1,39	1,70	0,46	-0,04	0,04
Turin	-0,12	-0,25	-0,54	-0,15	-0,48	-0,35	-0,49	1,06	-0,08	0,64
Trieste	-0,76	-0,78	-0,66	-0,25	2,45	1,62	1,44	0,72	0,26	-0,06
Venice	3,15	2,70	2,70	-0,31	-0,35	-0,07	-0,41	0,36	1,73	1,37

Tab. 6 Z-score calculated for the sector "Quality". Matrix 15*10 = 150 values. 59 positive values (39,33%)

Sector Index	ECONOMY		DENSITY / TERR. USE		MOBILITY		QUALITY
Milan	38,31	Milan	8,38	Milan	9,67	Rome	13,63
Turin	11,48	Turin	3,43	Rome	9,54	Venice	10,86
Rome	7,05	Rome	3,07	Venice	4,70	Florence	7,96
Bologna	4,80	Trieste	2,77	Trieste	1,69	Milan	5,58
Florence	2,83	Florence	1,67	Turin	0,73	Trieste	3,99
Genoa	-1,77	Bologna	1,32	Florence	0,22	Naples	0,77
Naples	-3,02	Naples	1,13	Genoa	-1,31	Bologna	-0,16
Cagliari	-3,61	Genoa	0,33	Naples	-1,42	Genoa	-0,29
Venice	-3,83	Venice	0,11	Bologna	-1,57	Turin	-0,75
Bari	-5,29	Messina	-2,55	Catania	-2,56	Cagliari	-1,96
Trieste	-6,26	Palermo	-3,43	Cagliari	-2,67	Bari	-4,84
Messina	-8,28	Catania	-3,62	Palermo	-2,96	Catania	-7,10
Catania	-9,56	Bari	-4,05	Bari	-3,23	Messina	-8,32
Palermo	-11,19	Reggio Cal.	-4,20	Reggio Cal.	-5,31	Palermo	-8,69
Reggio Cal.	-11,65	Cagliari	-4,35	Messina	-5,50	Reggio Cal.	-10,68

Tab. 7 Sector indices as sum of the Z-scores related to the indicators of each sector

Average Z-score	ECONOMY	DENSITY / TERR. USE	MOBILITY	QUALITY
Milan	2,74	1,40	1,61	0,56
Turin	0,82	0,57	0,12	-0,07
Rome	0,50	0,51	1,59	1,36
Bologna	0,34	0,22	-0,26	-0,02
Florence	0,20	0,28	0,04	0,80
Genoa	-0,13	0,05	-0,22	-0,03
Naples	-0,22	0,19	-0,24	0,08
Cagliari	-0,26	-0,72	-0,44	-0,20
Venice	-0,27	0,02	0,78	1,09
Bari	-0,38	-0,68	-0,54	-0,48
Trieste	-0,45	0,46	0,28	0,40
Messina	-0,59	-0,42	-0,92	-0,83
Catania	-0,68	-0,60	-0,43	-0,71
Palermo	-0,80	-0,57	-0,49	-0,87
Reggio Calabria	-0,83	-0,70	-0,88	-1,07

Tab. 8 Average z-score of the four sectors analysed. The order of the metropolitan cities comes from the results in the column Economy

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The value of the Z-score (total and average) shows the persistence of a case in the positive or in the negative field of the data and, then, the necessity of the policies to strengthen the obtained results or to change policies as to reverse negative states.

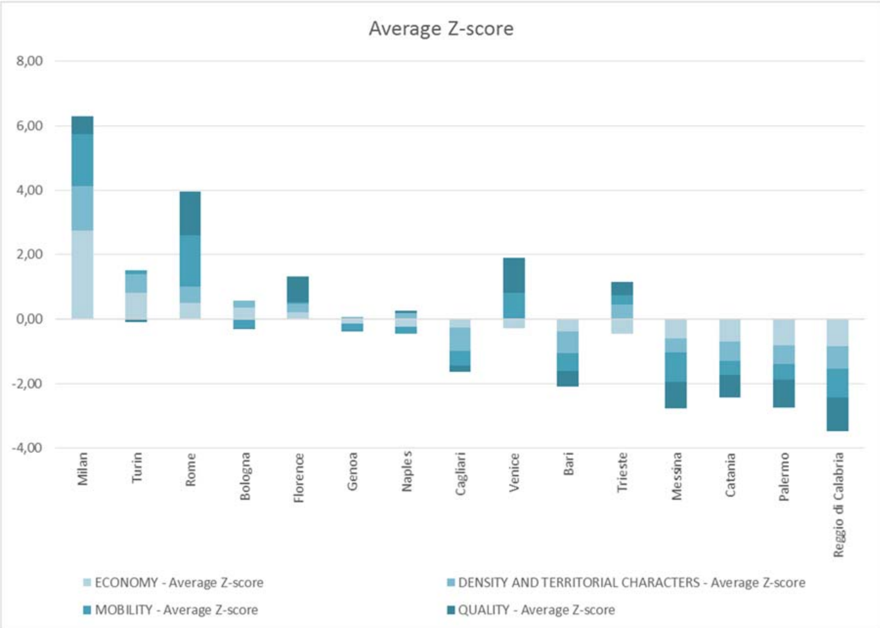

Fig. 4 Average z-score of the four sectors analysed

6 DISCUSSION

The above analytic formulation has confirmed results that, as a whole, are well known, as the Italian metropolitan system presents defined hierarchies based on qualitative considerations and on the economic, social, cultural and territorial performances of the cities.

From the calculations (Tab. 6, 7 and Fig. 3) it is possible to affirm that only three metropolitan cities have all of their Z-score positive (Milan, Rome, and Florence). Turin, Venice and Trieste have three positive and one negative value. Bologna and Naples two positive and two negative, Genoa one positive, Cagliari, Bari, Messina, Catania, Palermo and Reggio Calabria have all the negative values. In addition, the differences among Milan and the other cities are quite evident and, in negative, the distance of a wide number of cities not mainly from Milan but from the average.

The results obtained from this analysis identify the strength of some metropolitan cities and, at the same time, the weakness of others. In this category two types of cities can be classified. The first cities are those that, according to Italian law, are classified as metropolitan cities but, based on international literature and on their own characteristics, are nothing more than regional centers, difficult to consider as metropolitan cities or as a city with a real metropolitan area. The seconds are those belonging to the Southern area of Italy and, in this case, the weakness is structural and derives from a long history of inability to plan a future.

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7 CONCLUSIONS

International experiences in the field of metropolitan agglomerations highlight the need to treat the metropolitan areas as specific structures, clearly differentiated from the traditional urban systems. They, indeed, represent specific situations from the agglomerative point of view, and their management can require specific administrative structures as they represent areas of economic, cultural and social strength that must be developed and strengthened. The focal point is the necessity to bypass the daily administrative routine and to practice innovative strategies that are able to compete both at national and international level, working to increase the attractiveness of their territories both in the economic field and in the development processes based on innovation.

In this context, the institutional restructuring process that led to the constitution of Italian Metropolitan Cities had specific potentialities in itself, recognizable in curtailing of the territorial government, in growing of administrative efficiency, and in enhancing of competitiveness (Barbieri, 2015).

On the basis of these considerations, the first outcome of the paper has identified the strenghts of the metropolitan cities, namely the elements on which governance and innovation must act to master efficiency and visibility of the metropolitan system.

Secondarily, the paper has highlighted, on the basis of the performances reached by a number of cities of the sample, that they must not be considered as "metropolitan". Rather, their right size is that of a regional city, confirmed by the critical national and international size and positioning.

The choice to extend the number of metropolitan cities should be considered as negative. In fact a limited number (Milan, Rome, Turin, Naples, Florence, Genoa, and Venice) could have had a more effective impact on the new administrative instrument working on their strenghts. Furthermore, a limited number of metropolitan cities would have allowed to concentrate resources on the most representative cities of the Italian urban landscape in relation to size, economic and cultural weight, infrastructural efficiency and international visibility.Another not secondary element is the gap between the metropolitan cities of the Central and Northern Italy and those of the southern. The first show more attention to the strategic issues that may result by the creation of metropolitan cities, although critical aspects do not lack even in these (De Luca, 2016). The latter continue in the unconcealed aversion to all forms of planning and confirm a persistent inaction of the ruling classes, whose only strategy seems to be the preservation of their constituencies, compared to a clear lack of long term development vision.

The urban history narrates of different characters about planning and programming. The analysis of the Italian metropolitan cities can be referred to local areas that historically have had different attitudes towards planning, ranging from situations with a settled tradition of planning, to realities in which the plans are poorly tolerated. This makes it difficult to think, for some of the cities, to the possibility that they create a proper process of governed evolution of the territorial space.

This is a limitation of the Italian system that seems to be endowed with a high logical construction capacity accompanied by a very low application capacity aimed to achieving effective results. This applies to any problem, including that of the definition of the metropolitan areas system.

ANNEX 1 – DATA SET OF INDICATORS

Annex 1 contains the indicators used in this paper. They are organized in the sectors that the paper considers as strategic for the comprehension of the metropolitan phenomena. The first two number in the first column is the same used in Tab. 3 – 7.

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As reported in the paper, the indicators are mainly extracted by the data-base dati.italiaitalie.it of the Italian Government, containing a system of about 300 indicators coming by several sources (Istat, Infocamere, Tagliacarne, and so on), organized in themes going from work to environment, from mobility to innovation. This database is updated to 2015, with the more recent data dated 2014. From this database we extract 36 indicators, each of which is associated to one of the 4 sectors.

	ECONOMY
01-01EC-0027	Total added value at current basic prices – 2014
02-02EC-0044	Total added value at current basic prices per capita – 2014
03-03EC-0045	Total labour productivity – 2014
04-09RS-0498	Total patent applications filed – 2009-2014
05-11IM-0115	Density of non-agricultural active enterprises – 2014
06-13EC-0146	Manufacture of computers and electronic and optical products – 2014
07-14EC-0148	Manufacture of machinery and nca equipment – 2014
08-26CE-0386	Total exports – 2014
09-27CE-0387	Total imports – 2014
10-28CE-0388	Rate of openness of the economy – 2014
11-29CE-0470	Pavitt classification, traditional sectors – 2014
12-30CE-0471	Pavitt classification, specialized sectors – 2014
13-31CE-0472	Pavitt classification, scale-intensive sectors – 2014
14-32CE-0473	Pavitt classification, science-based sectors – 2014
	DENSITY/TERRITORIAL USE
01-06PO-1020	Index of old age – 2014
02-07PO-0026	Share of foreigners residing on the resident population – 2014
03-08PO-1004	Internal net migration – 2013
04-15PO-0218	Density of dwellings – 2011
05-16PO-0223	Non-residential buildings used – 2011
06-40S-SOIL	Consumed soil, percent on total MC area – 2016
	MOBILITY
01-21MO-0312	Air transport, aircraft movements, arrivals and departures – 2017
02-22MO-0313	Air transport, passengers, arrivals and departures – 2017
03-23MO-0360	People working outside the municipality of residence – 2014
04-24MO-4659	Demand for public transport – 2013
05-25MO-4665	Resident population moving daily for study or work in relation to the total population – 2011
06-33IC-0482	Total index of infrastructural endowment – 2012
	QUALITY
01-17TC-0249	Total tourist accomodations, beds – 2014
02-18TC-0275	Total tourist accomodations, tourist numbers – 2013
03-19TC-0288	Total tourist accomodations, presence of foreign visitors - 2013
04-20TC-0299	State museums, monuments and acheological areas, presences – 2014
05-34IC-0491	Total index of social infrastructures – 2012
06-35IC-0492	Total index of cultural and leisure infrastructures – 2012
07-36IC-0494	Healthcare facilities – 2012
08-37CS-0508	Spending of households per capita - 2012
09-38AM-0516	Environmental quality index, Legambiente – 2016
10-39AM-0520	Separate collection rate – 2016

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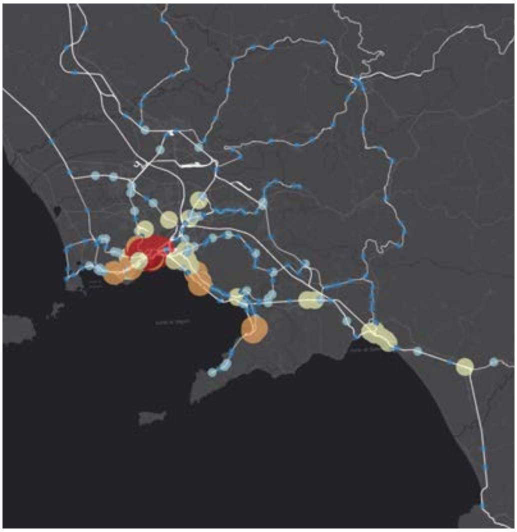

CLASSIFYING RAILWAY STATION CATCHMENT AREAS

AN APPLICATION OF NODE-PLACE MODEL TO THE CAMPANIA REGION

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ABSTRACT

In the last decades the local and regional authorities worldwide have expressed an increasing interest in the application of development strategies that combine transport and land use actions to reduces the impacts of the negative environmental and socio-economic consequences generated by the mobility needs in the urban area. Like many other regional authorities in the world, the Campania Region faces the problem to improve the existing transport network and optimize the land-use. The regional railway network consists over 3.017 km of lines and 339 stations, operated by three transport companies. The main action of the regional authority in next years is not just renewal of transport infrastructures, also to improve the land-use component in the catchment areas of the urban and peripheral nodes of transport. In order to support the policymakers and technicians, this contribute proposes a quantitative analysis of railway nodes in Campania Region in terms of transport and land-use characteristics, by drawing on the recent advances of node-place smart modelling literature. To increase the strength of our analysis, we used only open data referring to the catchment area (CA) size and analysed through an open source GIS software. Based on this systematic station inventory, we conducted a cluster analysis for all CA. In conclusion, this contribute proposes a GIS quantitative methodology of spatial analysis to support the strategic governance of regional/metropolitan railway network and the related application to the Campania Region.

KEYWORDS

Accessibility; Node-Place Model; Railway Network; GIS

1 INTRODUCTION

In the 2017, over 54% of the world population lives in the urban areas (The World Bank, 2018). Actually, the number of total urban population is equal 3.9 billion and the future prevision estimate over 6.4 billion of urban citizens (United Nations, 2017). Through these data, it is possible to understand the importance of developing new urban planning solutions to solve the present and future urban problems (De Gregorio et al., 2015). So, it will be important to develop new tools, approaches and guidelines for the analysis, quantification and solution the urban challenges. Some of the main challenges, of urban planning, concern the reduction of traffic congestion (use of the private car) and the unfriendly built environment. In particular, the urban areas are characterized by low level of density for the population and the activities, a monofunctional land-use destination of the areas and a no integration in the planning practice with transport planning (Papa and Bertolini, 2015). In metropolitan areas around the world, there is a growing interest in a more coordinated integration of transport and land use developments (Curtis et al., 2009; Curtis and Scheurer, 2016), as a result of mounting concerns over the adverse environmental and socio-economic effects of mobility systems dominated by individual motorized transport. In order to evaluate the present and the future impacts deriving from the application of integrated land-use and transport strategies, in recent years the need has emerged to develop several models of spatial analysis ex-post and ex-ante (Papa et al., 2018).

The most used model, in literature, is the Node-Place analysis model, proposed for the first time by Bertolini in 1998. It has been used numerous times and with some modifications to adapt it to different territorial contexts (urban and regional) (Zempt et al., 2011; Papa and Bertolini, 2015; Lyu et al., 2016; Caset et al., 2018). The model analyses the level of integration between transport (node index) and land-use (place index) systems by a set of indicators.

The original structure of the model is not applicable univocally at the different territorial contexts. In particular, the number and type of indicators must be changes to consider the different physical-functional characteristics of the case study and the availability of data for the calculation of the indicators.

For the application of the Node-Place model at a case study, it is essential to use the GIS spatial analysis software. So, it is possible to integrate spatial analysis for understanding the transport networks and urban areas in a more quantitative and more clearly interpretable way (Cheng et al., 2012). The paper is organized in three section as follows: Methodology (selection of node-place indicators, the GIS-based procedure); Case study (Campania Region Railway network); and Conclusions and future developments.

2 METODOLOGY

In consideration of the specific needed to apply at Campania Region railway network, the original node-place methodology has undergone some adjustments. We defined two different steps in the methodology. In the first, we selected a set of indictors through the studies of scientific literature on the application of Node-Place model at a metropolitan rail network. In the second step, we defined the GIS-based procedure to collect the data and to calculate the value of each indicator.

2.1 SELECTION OF NODE-PLACE INDICATORS

Several researches have proposed or selected different indicators to evaluate the characteristics of Node and Place index in different regional or metropolitan areas (Bertolini, 1999; Reusser et al., 2008; Zempt et al. 2011; Higgins and Kanaroglou, 2016; Lyu et al., 2016; Caset et al., 2018). For the development of this

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procedure, we selected a set of fourteen indicators (seven for Node and six for the Place) by systematic review of the recent scientific literature. This select set indicators also resulted from the use of the following two criteria: questionnaires at ten local experts (two urban researches, two transport researches, three urban planners and three transport planners); and publicly accessible of data (open data).

Index	ID	Indicator	Measurement	Data source
Node	N1	Frequency	Count the number of trains per day	GTFS data and RFI
	N2	Level of service	Count the number of different rail service (metropolitan service; regional service; long distance service; high-speed service)	GTFS data and RFI
	N3	Intermodality	Count the different mobility modality located in the node service area	Google maps data and RFI
	N4	Interconnection	Count the number of directions served	GTFS data
	N5	Infrastructure features	Typology of railway infrastructure (Single-track railway; Double-track railway; Single-track railway with electrification; Double-track railway with electrification)	OSM
	N5	Degree of attendance	Level of station use by the users considering the functioning time of rail service	Google maps data
	N6	Population trips	Count the trips of the resident population for reasons of work and study	ISTAT
	N7	Jobs trips	Count the trips of the resident population for reasons of work and study	ISTAT
Place	P1	Population density	Density of resident population within station catchment area	ISTAT
	P2	Jobs density	Density of jobs within station catchment area	ISTAT
	P3	CA Surface	Extension of station catchment area	OSM
	P4	Walking topography	Ration between walking catchment area and theoretical radius catchment area	OSM
	P5	Not urbanized area	Count the surface extension of the no urbanized areas	Corine Land Cover
	P6	Functional mix	Calculate on the basis of numbers of establishments in different sectors, and housing in the catchment area	ISTAT

Tab. 2 The selected Node and Place indicators

2.2 THE PROCEDURE OF ANALYSIS

After the selection of indicators and collect the data necessary for the analysis, we defined a procedure of the numerical and spatial analysis to calculate the two synthetic indicators of "Node" and "Place". Following, we describe the phases of our procedure:

- Building a GIS geodatabase to organize multiple sources spatial and alphanumeric data of the study area to calculate the value of selected indicators;
- Defying the pedestrian stations catchment areas (CA) by network analysis tool of ESRI ArcGIS Pro software (see Fig. 2). For this analysis, we considered Open Street Map (OSM) roads network and a walking distance limit of 10-minute from the station exits (amounts at 800m walking distance) (Vale, 2015);
- Calculating the values of fourteen indicators for each station node and CAs (place) of the network. Also, all indicators are normalized in to numerical range from 0 to 1 (Reusser et al., 2008);

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- Calculating the two synthetic indexes of Node and Place as the average of all standardized value of the same indicators category;
- Classifying the stations by the Cluster analysis tool of software package SPSS 20.00. In particular, we used two-step clustering method, that is frequently used in the Node-Place model application at regional scale (Norušis, 2008; Zemp et al., 2011). Also, the optimal number of clusters for the analysis can be calculated by the Bayesian Information Criterion (BIC) (Reusser et al., 2008);
- Illustrating the outcomes of analysis by the Node-Place diagram, GIS maps and tables.

Fig.2 Examples of calculated pedestrian catchment areas (CA) for some station areas of Campania region rail network

3 THE CASE STUDY

The study area is the Campania Region (a surface of 13,670 km^2 and a population of over 5,820,000 inhabitants) and its rail network (291 active stations, 3,017 km of lines and 3 transport companies). The region is divided in five provinces (Avellino, Benevento, Caserta, Napoli and Salerno) and 550 municipality authorities. A great part of population and economy activities of the region are located in the territory between the cities of Naples, Caserta and Salerno. In the last two decades, the Campania region government and some municipality authorities invested a lot of recourses to increase the efficiency of the regional railway network and to improve the quality of urban texture (denser and more land-use mix) around the stations (Comune di Napoli, 1997; Pagliara and Papa, 2011). For this application of Node-Place model at the Campania region, all data refers to the year 2011.

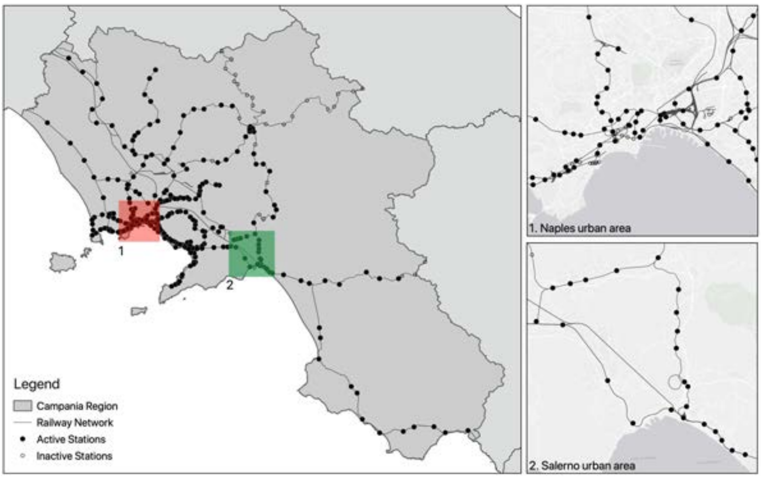

Fig.3 Railway network of Campania region

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3.1 RESULTS

In the Tab.3, Fig.4 and Fig.5 are illustrated the clustering structure obtains with the application at Campania Region railway netwoek of Node-Place model. The Cluster 1 includes the "Poorly served station areas" and counts 35 station areas. Most of these station areas are located along the secondary railway lines of the network. In the node-place diagram, these stations are located in the "Dependency" and in the "Unsustained Place" area. The place and node index values are low, only the value of Not urbanized areas (P5) index is over the mean value.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Network
Number of Stations	35	40	16	111	66	23	291
N1 - Frequency	0.036	0.102	0.080	0.192	0.376	0.742	0.255
N2 - Level of service	0.200	0.237	0.313	0.667	0.939	0.978	0.556
N3 - Intermodality	0.143	0.250	0.300	0.249	0.391	0.800	0.356
N4 - Interconnection	0.229	0.200	0.281	0.204	0.237	0.449	0.267
N5 - Infrastructure features	0.391	0.867	0.063	0.868	0.985	0.978	0.692
N6 - Degree of attendance	0.015	0.683	0.633	0.581	0.639	0.805	0.559
N7 - Population trips	0.005	0.220	0.705	0.184	0.194	0.370	0.280
N8 - Jobs trips	0.014	0.060	0.059	0.070	0.171	0.679	0.176
P1 - Population density	0.051	0.048	0.131	0.187	0.463	0.673	0.259
P2 - Jobs density	0.016	0.013	0.044	0.047	0.114	0.444	0.113
P3 - CA Surface	0.268	0.233	0.543	0.513	0.612	0.741	0.485
P4 - Walking topography	0.250	0.220	0.502	0.487	0.580	0.698	0.456
P5 - Not urbanized areas	0.579	0.624	0.398	0.238	0.110	0.084	0.339
P6 - Functional mix	0.215	0.312	0.314	0.308	0.229	0.404	0.297
Node index	0.129	0.327	0.304	0.377	0.492	0.725	
Place index	0.230	0.242	0.322	0.297	0.351	0.507	

Tab.3 Results of cluster analysis by Two-steps method SPSS statistic software

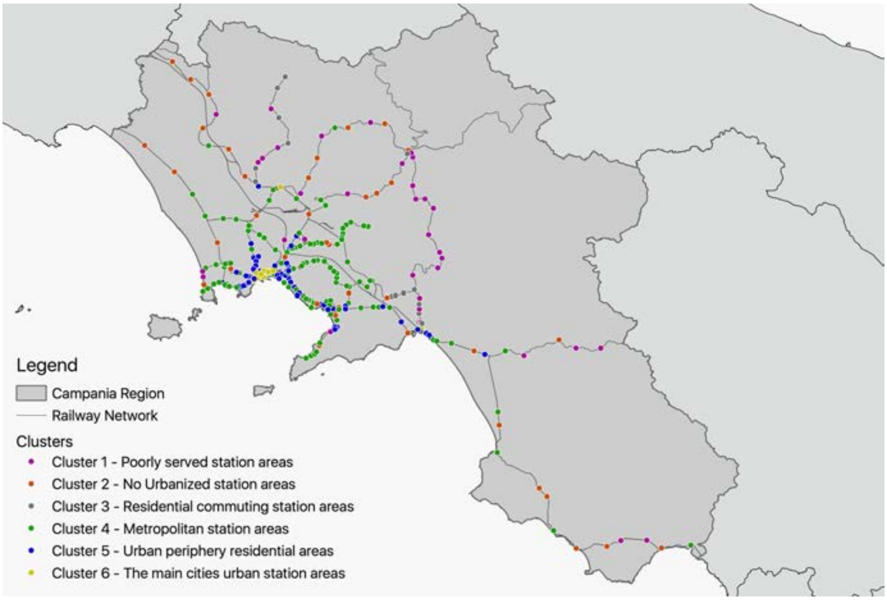

Fig.4 The classification of railway station areas in Campania Region based on the Node-Place model

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We named station areas belonging to Cluster 2 "No Urbanized station areas" and counts 40 station areas. A lot of station areas are localised in the peripheral areas of the region. The cluster is characterized by the lower value of Population density (P1) and Job density (P2). The station areas of this cluster are located in the bottom of the accessibility area in the node-place diagram.

The Cluster 3 groups "Residential commuting station areas" and counts 16 station areas. The areas of this cluster are localized along the no electrified single-track railway in the north of province of Salerno and in the province of Caserta. These are positioned in the accessibility area of node-place diagram. The value of population trips (N7) is high but the frequency of service (N1) and infrastructure features (N5) are very low.

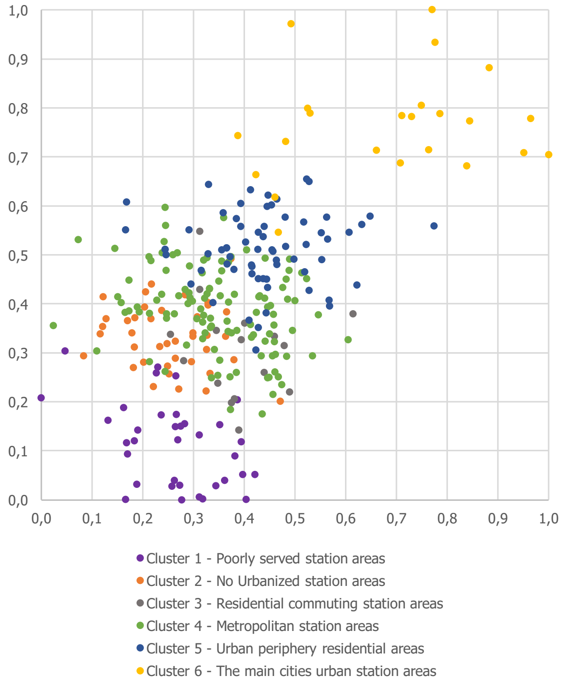

Fig.5 The Node-Place diagram of Campania Region railway station areas

The Cluster 4 includes "Metropolitan station areas" and counts 11 station areas. In the Node-Place diagram, the elements of this cluster are located between the bottom and central of "Accessibility" area. A lot of stations are included in the part of the region between the three cities of Naples, Salerno and Caserta. The numerical values of fourteen indicators are near the respective average values.

The Cluster 5 includes "Urban periphery residential areas" and counts 66 station areas. These stations are located in the central part of "Accessibility" area. The station areas are localized very close to the city centre of Naples and Salerno, on the most served (N2) and powerful (N5) railway lines.

Finally, the Cluster 6 includes "The main cities urban station areas" and counts 23 station areas. The stations of this cluster are located in the "stress" area of Node-Place diagram. This cluster are characterized by the low value of not urbanized areas (P5) and high values of a lot of indicators.

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3 CONCLUSIONS

This first application of Node-Place model at the Campania region railway network as a preliminary step of research work to define integrated land-use and transport guidelines to improve the transit orientation of station areas. The selected set of indicators (7 for the Node and 6 for the Place components) was improved by the study of scientific literatures on Node-Place applications, experts knowledge and availability of open data. The application of cluster analysis at the selected indicators of the 291 railway stations determined six type of stations groups. The application of the cluster analysis at the selected indicators for the 291 railway stations determined six type of stations groups. Each group is distinguished by specific characteristics of infrastructure, the transport service, socio-economic conditions and geographical location. These results from the application of the proposed procedure are useful for pre-selecting stations or corridors needing further investigation in the transport and land-use planning process.

Further elements of investigations might include, in our opinion, increase the number of selected indicators, apply a correlation analysis to choose the final set of indicators, define a set of planning strategies for each group of stations and propose specific transport and land-use planning solutions to increase the balance between the Node and Place components of the stations for each group.

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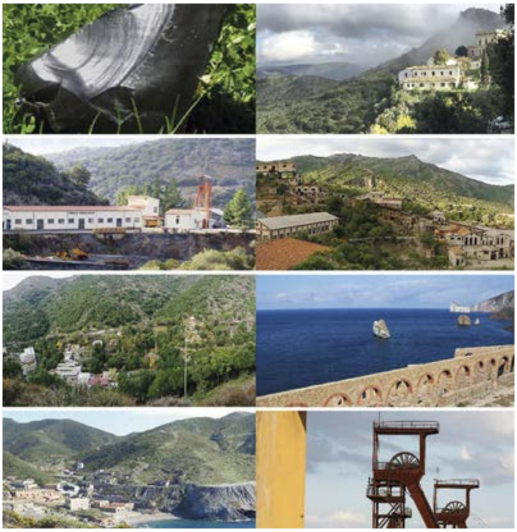

SOCIAL CONSTRUCTION OF SPACE IN HERITAGE CONSERVATION

GEO-MINING PARK IN SARDINIA

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ABSTRACT

Like many other post-mining regions in Europe, Geo-mining Park in Sardinia faces severe socio-economic crisis designed by the increasing trend of neglecting the mining landscapes and depopulation. The Sardinian post-mining phenomenon characterizes the low operational capacity of the Park and exclusion of the civic sector from the making decision process resulting in the disposal of spatial dynamics and loss of identity. In order to reverse these negative trends, the paper elaborates new and changing concept of heritage as a theoretical concept in heritage and urban research and its application to the Sardinian case. The paper examined aspects and components of heritage conservation and the pivotal role of peoples' activities, social construction and production of space and, local community practices as development approach to the heritage. In addition, the paper argued importance of the geographical concept of scale and levels, degrees or extents to the heritage concept. In conclusion, the paper indicated heritages values as a living idea to fund sustainable development strategy for the Geo-mining Park in Sardinia. Comprehensive understanding of heritage, interpretation and reinterpretation of cultural identities and essential role that plays public participation are three main pillars contributing both, well-being of the local community and heritage conservation that narrates the past lives and mining activity through contemporary local practices.

KEYWORDS

Heritage Conservation; Social Space; Geo-mining Park; Sardinia

1 INTRODUCTION

The Geo-mining Park in Sardinia aims to protect the technical-scientific heritage, historical and cultural landscape and environment related to human events that have interests in the geology and mineral resources of Sardinia (UNESCO et al., 1998). Given the recognition by UNESCO in 1997, patrimony fields gained a universal value and international importance. Geo-mining, historical and environmental particularities reflect complex heterogeneity and qualitative advantage of the heritage sites scattered all around the Sardinian Island, but it has been acknowledged as a regionally unique system resulted of centuries of mining extraction. In Italy[1], mining parks can be the consequence of mining activity partially or entirely, having the diverse scale, and following different bureaucratic processes. They are representing the same production system; the anthropogenic articulation of the geological structures and often, several elements point out the history of the activity (e.g. mine processing system and other). The items can be physically distant, but the essence of the system is the spatial continuity of the mining activity (ISPRA, 2008). Hence, the tangible heritage of landscape modifications is inseparable from immaterial relationships of the space and peoples' activities during times. The dimension of scaling, holistic perspective, more human and dynamic heritage (Harvey, 2001; Loulanski, 2006; Sheppard & McMaster, 2004) follows the conceptual development at a global scale. The traditional concept of heritage preservation shifts the nature of the understanding the term heritage and focuses towards heritage conservation that recognizes heritage values as a living idea and 'contemporary product shaped from history' (Tunbridge & Ashworth, 1996). The new conception of heritage requires both, a new approach in planning and management. The research has a qualitative character and pragmatic orientation starting from the Sardinian Geo-mining Park context and problematic issues (even though the research process is rather iterative). The research uses mix method, common in the elaboration of the 'transformative paradigm theory' (Creswell, 1994).

2 NEW SOCIO-SPATIAL CONTEXT OF HERITAGE

Heritage is a vague and extensive term, which includes natural and man-made legacy and there are "many definitions of the heritage concept as there are heritage practitioners" (Harvey, 2001). An intensive period of heritage as modern and global industry arises after the 1970s with the role of heritage in 'restructuring of the world economy' and 'museum culture'. Discourse emphasizes the objects of culture (rather than cultural practices) concentrated on providing historical memories and institutional support to access the past in the present archives and preservation societies (McCabe, 1993). Unfortunately, the heritage lost critical culture that engages in a dialogue between past and present (Harvey, 2001). The evolving heritage concept is sensible to change, and is actually changing. The evolution and expansion of the concept in both scope and direction paired with the new environment and sustainable development issues. "Strengthening efforts to protect and safeguard the world's cultural and natural heritage" (SDG, 2015) became even a UN-habitat sustainable development goal2. However, the idea of sustainability opened up the path to the time-space

[1] National contextualization of the Geo-mining Park is common for a few countries in Europe (Spain, UK, France), not worldwide as well. The closest term in UNESCO global context is 'mining landscape' or 'mining region' category of industrial heritage by the definition of The International Committee for the Conservation of the Industrial Heritage - TICCIH.
[2] SDG - Sustainable Development Goals are the instruments of New Sustainable Development Agenda (2015-2030) of United Nation Habitat programme aimed to decrease poverty, protect the planet and ensure prosperity for all.

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continuity of heritage opposing previous preservation character. The conceptual dynamism of heritage is natural, as people according to their contemporary concerns and experiences (Harvey, 2001) produce it. New heritage conservation process is favourable to people, function, use and development. Heritage resources are a way of ensuring their maximum possible vitality, values and functions to benefit of current and future generations, attributing them an important role in a sustainable social system. In the last two decades, with the help of public participation, people-oriented, and bottom-up approach in heritage conservation, strengthening the local capacities over recognition and inclusion of local communities in the decision-making process is identified vital for more sustainable development. Additionally, participation process as an integral heritage conservation approach delineates the features that give a unique character and provide the sense of identity, pride and belonging. They are lying at the core of the cultural identity of the heritage site. In that manner, public participation and the role of local communities in the decision-making process are the axles of heritage conservation enabling continuity of cultural identity.

2.1 SOCIAL CONSTRUCTION OF SPACE AND SCALE IN HERITAGE CONSERVATION

"The (social) space is a (social) product" (Lefebvre, 1991). Politics of space and certain social relations produced in the interaction of space and time determines production of space trough constant shifting of social production and reproduction to ensure the room for social system as long-term sustainability of place. The social construction of space rests on stable and pre-political features as the dynamic and constantly re-created within new contexts and new tensions. Given an ongoing significance to heritage dynamics, people and present times, the focus of heritage studies is the identity of the population interpreting the heritage 'object' (Taylor, 2008). Social landscape demands attention to the active making and construction of space through people's activity, where space becomes a neutral grid on which cultural difference, historical memory and societal organization are inscribed (Gupta & Ferguson, 1992). Cultural conceptions, everyday practices, and social constructions effect and reflect spaces. The relationship of space and identity is a unity of place and people that "masks the processes of *production* of difference in a world of culturally, socially, and economically interconnected and interdependent spaces" (McCabe, 1993).

Spatial configurations are a symbiosis of symbolic and material and, they are as much cultural constructions as economic constructions are. To act beyond mass culture thesis (also, industrial heritage and heritage tourism concepts etc.), cultural construction must not be a reaction or response to economic processes, but it has to precipitate the intimate binding. "No space disappears in the course of growth and development: the worldwide does not abolish the local." (Lefebvre, 1991) Place and heritage, both involves regionalisation of experience and a localisation of identity and tradition; particular spaces at multiple scales. Definition of heritage scale is the basis for the development and management of the conservation process. Scales involves values and interpretation of heritage, and the stakeholders involved. It has already been argued in the introduction that the issue has crucial importance for the Geo-mining Park in Sardinia regarding both, heritage types and people involved. This paper focuses on the people involved with the heritage.

2.2 PUBLIC PARTICIPATION IN HERITAGE CONSERVATION

Public participation is essential for the heritage conservation programme (ICOMOS, 1987), enabling heritage transfer to the future generations. The roles of public participation in heritage conservation can vary, but the paper highlights the pivotal role of cultural aspect and shift from the purely architectural and historic approach to heritage conservation towards the society and cultural conservation (Tweed & Sutherland,

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2007). Development politics concerning social capital firstly concerned 'community-based management' as a market-oriented approach and 'participative governance' appears as a substitute for the 1990s (Ballet et al., 2007). Participative governance emphasizes the role of the civic sector (NGO, NPO, associations, formal and non-formal groups of citizens, etc.) and need to "joins with governments and industrial lobbies in a common decisional pattern to achieve agreements between the three parties." (Ballet et al., 2007). Correspondingly, local and civil practices and experiences that are relevant to the subject of heritage should lead to the establishment of strategies development. With everyday life practices, this approach could help the sustainable territorial planning of the Geo-mining Park in Sardinia by embedding the 'norms of trust'. The concept of 'community of practice' represents a group of people who interact frequently over periods of time and who perform a shared practice and address tasks in a specific domain. Thereby, they continuously exchange experiences, learn from each other and strive to align upcoming challenges with their shared norms and perceptions (Wenger, 1999).

The concepts of social capital and capacity understood as "social networks and the norms of trust and reciprocity that flourish through these networks" (Sander & Lowney, 2006) supports mapping and managing the community practices. The authors explain that the social capacity distinguishes from the social capital in the major concentration from relational patterns about the collective activity. Thus, the variable distinguishes four types of social capital: public/private regarding, formal/informal, bridging/bonding social capital and, strong ties/weak ties. Assessment and characterization of resources help the development process defining condition about stakeholders from the civic sector, social potentials, paucity and revealing if the ties are strong or weak and what are the strengthening possibilities for local communities and pertinent to the heritage places. These types of researches are willing for Geo-mining Park in Sardinia.

3 GEO-MINING PARK IN SARDINIA CASE

Distinctive and heterogeneous mining culture marks the Sardinian island dating back to the Obsidian extraction around six millennia BC (UNESCO et al., 1998). However, large-scale territorial specialization in mining activities has been detectable just from the modern age of mining industry (eighteen-century). The mining industry became the first economic branch of the island in the period. Rapid changes after the World War Two, shaped by "substantial political trade-offs and long-term phasing-out scenarios" (Wirth et al., 2012), were leading the mine closure all around Europe.

Sardinia shared the same destiny, and most of the mines were closed in the 1960s and the 1970s. After the closure of the mines, many mining settlements quickly depopulated and left behind oversized dilapidated ex-mining infrastructures and faced a deep socio-economic crisis. The ex-mining territory did not change much of the crisis period. During the termination of mining activity in Sardinia petrochemical and metal industry evolved as a derivate of the post-mining phenomenon. However, the industrial shift was not about the shared development project of the ex-mining territory. It was far from involving local communities and lack of confidence in self-organization (Perelli et al., 2011).

The post-mining phenomenon funds the exclusion of civic sector from the decision-making process and loss of identity (Perelli et al., 2011). Parallel to the mining extraction decay, the heritage idea and active cultural debate were growing from 1975, promoted by academics and experts in mining engineering. Hypothesis and plans were developed since 1975, but nothing indicated implementation. Inhabitants of the villages next to ex-mine Arenas stood out seeking the realization of some development plans, letter in 1987. The protests did not bear fruits. Geo-mining Park of Sardinia as UNESCO heritage is institutionalized in 2001. Seemingly, the Sardinian Geo-mining park is the most participative project on the island since about 35 percent of the

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total inhabitants of the region live within its boundaries and 81 municipalities seem to be involved in its management. However, the practice is not affirmative to these initial insights about the participation. Administration and legislative opportunities at the regional, national and international level followed by top to down institutional practice demonstrates minimal efficiency and exclusion of the civic sector from making decision process.

4 CONCLUSION

The paper concerned new and changing concept of both tangible and intangible heritage that focuses conservation upon preservation and celebrates the social construction of space as a sustainable dimension of a heritage. Firstly, heritage needs a comprehensive understanding of types and the practice of conservation of resources given heritage values as a living idea. Secondly, interpretation and re-interpretation seems necessary, including time-space continuity of cultural identity. Thirdly, stakeholders, people and their actions in present times, their emotions, intuition and recognition of the roots of value are the processes of celebrating heritage values through their periodically deepened interpretation and reinterpretation. Fourthly, while arguing the physical scale of heritage paper pointed out that the local dimension cannot be overshadowed by global until the production of space is real and produces identity.

Geographies of space are a positive distraction to experience territory on a scale of the place. Public participation is focal for all mentioned findings community practices determinate the place and they are a guideline for an approach to heritage and sustainable development. The case of Geo-mining Park in Sardinia illustrated irreplaceable time-span of a UNESCO heritage with universal values that are marking astonishing landscapes of the Island, pervaded only by nostalgia.

Moreover, it represents about ten years of bureaucracy without any implementation, more than twenty years of top-to down institutional efforts without strategic development approach and neglecting of people's hope about the future all along these processes. To reverse the negative trends, new socio-spatial contextualization of heritage needs to narrate the past lives and mining activity, but through the present communities and stepping out from the gap of instant acting through reaction to the past. To base a strategical heritage approach to the social construction of space, the local practices have to be recognised and local communities included in the decision-making process as vital for more sustainable development. The paper suggests more research on social construction and production to construct a development approach for the future of Sardinian heritage.

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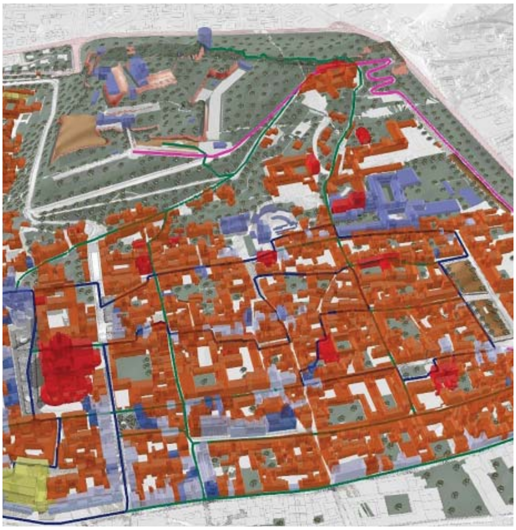

ENHANCE THE HISTORICAL CITY WITH NEW TECHNOLOGIES

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ABSTRACT

In 2016 the Municipality of Brescia approved the new Urban Plan of the City in which importance was given to the enhancement of cultural heritage. The aim of the Plan is to draw a guideline for sustainable development for the territory and in the urban center this idea was translated into a maintenance program for the protection of historical heritage. The program concerns two aspects: historical buildings and open spaces; this because importance was given to the urban core as a single entity composed by monuments and large squares but also to other types of assets that are important to maintain the identity of the ancient city. The paper illustrates a work done by the authors, which consisted in setting up a methodology aimed at building a database with GIS software. The starting point was the construction of the cognitive framework, collecting data about buildings, open spaces and people, which were put inside the database. With the GIS software it was feasible to highlight these data into specific maps. Then a web-map application, available also on smartphones and tablets, was created with a double value: the first is that it allows to manage all the information about the urban core and, on the other side, it can be used as a guide map during the visit of the site. So, a support tool for the urban plan was provided, to promote the potentiality of the site and to create the conditions for its sustainable development. The paper goal is to explain the method devised and employed and to show its possible future applications considering that the Municipality of Brescia is carrying out many projects in the way of recovering historical buildings and increasing the cultural and tourist attraction of the city.

KEYWORDS

Cultural Heritage; GIS; Smart and Resilient City

1 INTRODUCTION

In 2016 the Municipality of Brescia approved the new Urban Plan of the City (PGT) with the aim of reducing consumption of agricultural soil and promoting a strategy based on the restoration, the refurbishment and the recovery of the parts of the city that have been already built, so the new PGT gives importance to the enhancement of cultural heritage, namely to architectural monuments and to the open spaces. This strategic vision wants to promote the growth of Brescia not under a quantitative point of view but through a sustainable development in which there is a strong collaboration between the Public Administration of the city and the private stakeholders (Tiboni, 2015). At the base of this sustainable development there is the will to use the resources of the territory itself and to create the conditions to make these resources last in time. The Public Administration must promote best practices aimed to increase the value of the areas of the city in a way to encourage the private stakeholders to restore their properties and to create better places to live in. To make these projects feasible, it is important to have a strong system of knowledge that can support the designers. The cognitive framework must collect the features of the assets and of the city users but also, with the will to promote participation, the wishes of citizens. All these operations can help in solving problems for cities of medium dimensions and characterized by a strong industrial vocation. This paper wants to analyze how the Municipality can work on the urban core to develop best practices to protect and enhance the historical heritage and stimulate private owners to do the same, with the aim of emphasizing the peculiarities and potentialities of this part of the city, making it more attractive under a socio-economic point of view. To advance the right strategy, it is important that the projects are strongly linked to the assets features and to the people that enjoy them. The other important topic concerns the use of GIS software to create a database of the heritage in which information is linked to the object it refers to. This database contains data coming from the surveys and from ancient documents like cadastral maps and old paintings of the site. This database must be implemented with data regarding people's behaviour and the way in which they move inside the area. All this material is the system of knowledge that is made available to the Municipality to decide which are the best practices to adopt to enhance the cultural heritage.

The aim of this paper is trying to define a way, starting from the analysis of building, open spaces and people, that can show how new technologies can be implemented to increase the value and the attractivity of a city. To do this it was necessary to develop a methodology that allows to highlight the peculiarities of the site. As case study, the area investigated is the most ancient part of the city centre. This place is very important because it coincides with the first urbanisation of Brescia and, during the centuries, it has been marked by important transformations under an urbanistic and architectural point of view. This is also the part of the city in which there are the most important archaeological evidence and the museums, so it is feasible to say that is the most important area of the city under the touristic point of view.

2 URBANISTIC OVERVIEW OF THE CASE STUDY

The site object of the analysis is located inside the urban core of Brescia. It is the area that, starting from the Castle, goes down on the slopes of the Cidneo hill. The core of the site coincides with the ruins of the ancient Roman city, that are now visible in Piazza del Foro. The borders of the site are Piazza Loggia and Piazza Vittoria in the western part, Piazza Tebaldo Brusato in the eastern side and Corso Magenta in the south (Fig. 1). As it was said before, inside this area there are all the most important monuments that symbolize the transformations occurred during centuries in Brescia. The most important of them are the

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Ancient Cathedral and the New Cathedral, the Broletto with its tower and the Loggia Palace which is the core of the Municipality, but there are, also, a lot of other important churches, palaces and squares that are smaller than the others abovementioned but are important to maintain the identity of the ancient city (Lombardi, 1989). It is feasible to say that in this place there is a mix of natural, archaeological and monumental proofs. This is the reason why the Municipality and the Superintendences give such importance to it. This area is also one of the most livable in the city because it is characterized by a high density of houses and, also, there are some of the most important shops and museums so, in every moment of the day there are city-users. Under an urbanistic point of view, the site is characterized by a promiscuity of pedestrian paths and vehicle accessible roads, this is one of the main point of the research about the enhancement of the open spaces. There is also a mix of historical cobblestones and contemporary asphalt streets and this creates huge problems with the Public Transport Lines. It is important to say that the area is well serviced by three underground stations and bike sharing service is also developed on the territory. This means that there is a strong policy that wants to promote pedestrian fruition of the city centre.

Fig. 1 Brescia city centre; satellite view of the case study area

3 SOME PRELIMINARY DEFINITIONS

During the elaboration of the PGT, the Archaeological Superintendence of Brescia asked the Municipality to create a site, called "Archaeological Park", that, according to UNESCO guidelines (UNESCO, 2014), must protect the archaeological evidence such as Capitolium Temple, the Roman Theatre and the old ruins inside the Castle site on Cidneo hill. As UNESCO says, the focus of the area is the part of the city in which there are the most important evidence and it is called "Core Zone" and in the case of Brescia it is the Roman area in Via Musei; all around the Core there is the "Buffer Zone" that is a place in which there are other

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archaeological and monumental evidence and has the role of buffer between the rest of the city and the Core. The Buffer Zone coincides with the area of the case study (Fig. 2).

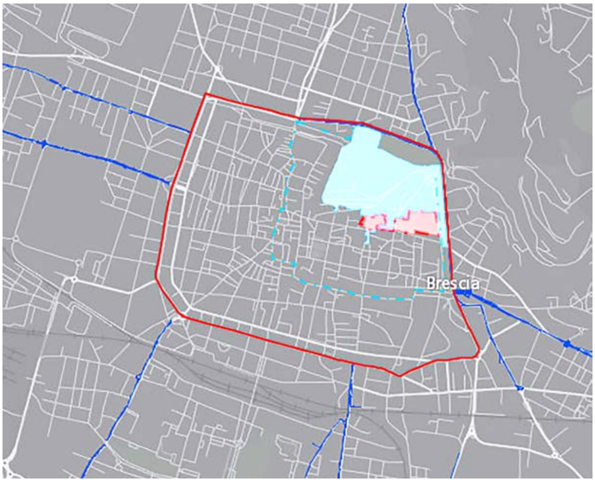

Fig. 2 The definition of the different areas composing Brescia urban core; with the red continuous line there is the perimeter of the city centre, with the blue dashed line there is the Buffer Zone and the red area is the Core Zone

The strategy adopted with the new PGT is to allow this site to grow under the socio-economic sphere. To do this it is important to create an operational method that must protect and enhance the heritage and, at the same time, can make the city centre resilient to sustain touristic flows. Before starting to describe the developed process, it is important to explain the meaning adopted in this paper for the concept of resilience. The background is the sustainable development of the territory and, to do this, it is important to define which are the features that mostly characterize the area. To obtain this kind of growth it is necessary that the features won't deteriorate in time, so, it is needed to create a system in which people can enjoy them without damaging them (Europa Nostra, 2013; Sgobbo & Moccia, 2016). The development of Brescia city centre is given by tourism, so it is demanded to the area to be able to host tourists and city users. This policy, adopted by Brescia Municipality, flows into a deep analysis of the features of monumental architectural and archaeological heritage to create a detailed legislation that regulates operations and works on constrained buildings and open spaces. With this aim, it is necessary to understand how people move and how they use the heritage to avoid wrong behaviours that can damage it. In this case, the resilience is linked with the concept of smart tourism because there is a strong relation between people and site (Russo, 2014; Ventura & Tiboni, 2016). This relation is emphasised also with the use of GIS that permits to create web-maps that can show to users the best way to enjoy the assets. Smart tourism, in this case study, means clever and sustainable tourism that allows to visit places and monuments, also with the support of new technologies, in a way that help maintain the city alive.

4 HOW TO USE GIS TO CREATE A RESILIENT CITY

The surveys were the starting point of this research. The inspections of the area allowed to define the features of the monuments and of the open spaces. On detail, it has been feasible to georefer all the

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features needed to define the detailed legislation. Thanks to the GIS software it was possible to create maps in which all the data collected in the database are highlighted to define which parts of the city centre most need a public intervention. The analysis concerns the buildings and the open spaces located inside the Buffer Zone, so two different databases were created. In each database there are information about the typology, the state of conservation, the trigger causes that can damage the object, the potentialities and the weaknesses that can be translated into opportunities or points of strength. This cognitive framework allows to define which is the best strategy of intervention on the heritage and it is a very helpful tool for designers. The purpose is to define a guideline developed by the Municipality but also adopted by the private sphere to create an organic site in which tourists can recognize the Park. The first database created is the one regarding the open spaces. In this phase of the work a help was given by the ancient cadastral maps and ancient representations of the squares and streets. Thanks to this study it was feasible to obtain how the area was in the past and how it evolved in the centuries. Comparing the old paintings with the pictures taken during the surveys allowed to define how the site changed and which are the element that are not compatible with the context and with the history of the site (Fig. 3).

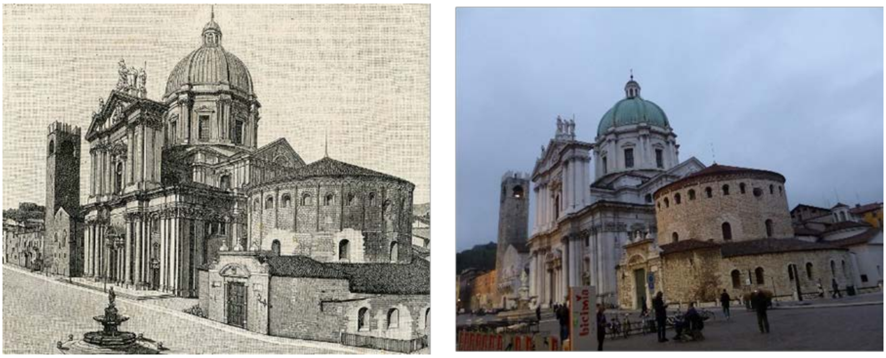

Fig. 3 Comparison between an old print of Piazza Paolo VI and a picture taken during the surveys

The analysis of the open spaces regards the historical value they have and the elements that don’t permit to enjoy them. This aspect has deep consequences because it involves various features such as the Public Transport Lines, car parks, viability and accessibility inside the city centre and, also, the street furniture and paving. It emerges how starting from the will to create the condition to make urban core more attractive, there are a lot of consequences in different spheres. This is because in this area there are a plenty of different activities and social functions that require different services but that must operate together to promote the social development of the site. So, it has been necessary to study how people live and how people move inside the Park; this allows to define where and when there are the most intense flows (Rossetti et al., 2015). The analysis allowed to define two different aspects: where people are, that is important because it permits to know which parts of the city are more stressed and, on the other side, it also allows to know if there are part of the Park that are important under touristic point of view and in which there aren’t tourists. This data, in the hands of the Municipality, can guide to a strategy of intervention with the aim of promote the parts of the Parks in which there are important monuments, but people don’t know (Fig. 4). This is also linked to the creation of itineraries of sustainable mobility in which pedestrians are protected and to rethink the viability and the politics about parking inside the city centre (Carmona, 2003).

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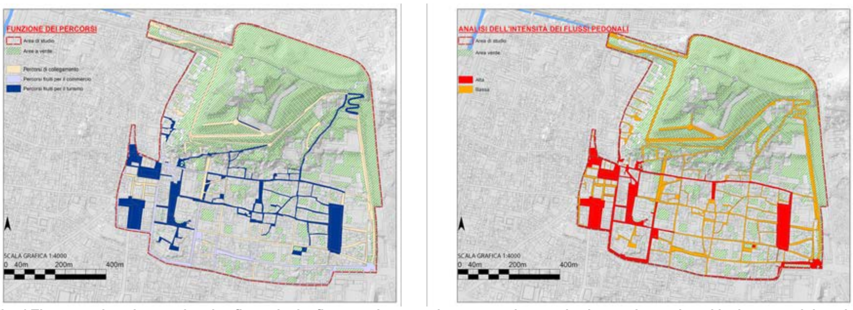

Fig. 4 The maps that show pedestrian flows; in the first one there are the reason why people choose that path and in the second there is the intensity of flows

This policy is thought to enhance the monuments and their fruitions. Now this is obstructed by the strong presence of cars. These operations done by the Municipality have the aim to increase the attractivity both on the touristic side but also on the economic one. Work on the open spaces can create a better city for city users that can visit the Park in an improved way, but also for the citizens that can have healthier spaces in which they can live in. This is because intervention by the Municipality can stimulate the private stakeholders to refurbish their buildings too. To create common guidelines to restore buildings the system of knowledge investigates also their features. That database of buildings starts with the exam of the ancient residential typologies and for each type identifies the architectural characterizing features, then each type was associated to a technological system that has specific properties and specific weaknesses. This is to define which is the best way to restore buildings; the strategy of intervention must be calibrated on the features of each type and, inside the Park, every building belonging to a certain type has to be treated as the others. The aim of this operation is to develop guidelines, shared also with the private sphere, in which it is said how to work to let the monuments to last in time and to create a toolbox in which every designer is oriented in the choice of the correct intervention (Figg. 5, 6). This is an example of how the public intervention on the open spaces can have consequences on the enhancement of monuments and on the increasing of value of the private buildings. This extra value can be used to restore structures with intervention of energy and seismic adaptation to make a part of the city more efficient and attractive. This is also an example of how a Municipality can encourage the private stakeholders.

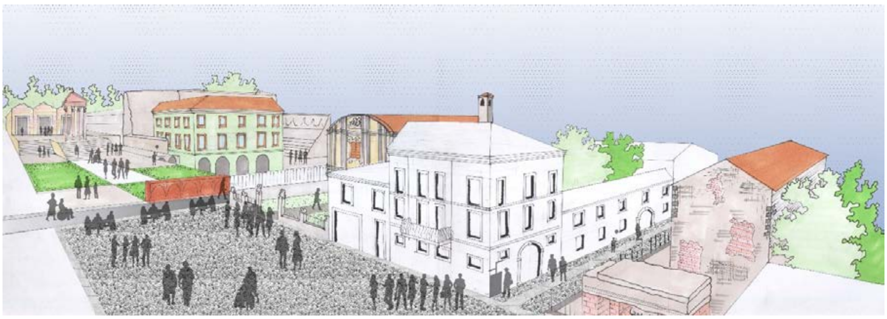

Fig. 5 Example of restoration of the open spaces according to the guideline: Piazza del Foro

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Fig. 6 Example of restoration of the open spaces according to the guideline: Piazza Paolo VI

Increasing the flow of tourists can increase the visibility of an area and so people are stimulated to operate in that part of the city because they will have an economic response. In this case study importance was given to the creation of the system of knowledge at the base of urban planning. GIS software is very useful in spreading information because it allowed to draw thematic maps, one for every feature contained inside the databases. It also permitted to create a web-site in which all the databases are displayed at the same time (Fig. 7).

Fig. 7 The display of the web-map; it is possible to see that by clicking on a polygon appears the database related to that element with all the information

This is an important instrument because it gives a picture of the Park in which there are all the information needed to develop a plan for maintenance and management which is also demanded from the UNESCO (UNESCO, 2014). Inside the web-map it is possible to link all the information that are inside the database and it is also possible to implement it with sheets and pictures. The web-map has a double meaning: on one side it is a tool for designers because it contains the guidelines for interventions inside the Park and on the other side it can be used as a guide map for tourists. The web-map can be displayed on smartphones and tablets, so it is feasible to have a look at it while tourists are visiting the area. This can help people to find monuments and places that are important under historical point of view but not so famous as the most important monuments of the site. With this map the users can see different paths and which monuments are located on the route they choose. This map is organized with many paths: the most important is the one that links the most part of monuments and squares and let the tourists walk along the ancient streets to see very different things coming from different centuries. The other routes are the secondary ones and they are

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called “thematical” because they link parts of the city belonging to the same historic period such as the Roman path, the Medieval path, the Baroque path and so on (Fig. 8).

Fig. 8 In the first picture there are the different paths: the blue one is the main path and the red ones are the thematical paths. In the second one there is the related database in which it is possible to see the photo of the monuments that are placed along the routes

5 FROM SMART TOURISM TO SUSTAINABLE DEVELOPMENT

As it was said before, inside the database it is feasible to put links to external elements.
So, in the web-map there are links to pictures of the monuments and of the squares. It is enough to choose one of the path and then the users can see which things there are and, most important, where they are. This aspect can be implemented with information about other things beyond monuments such as shops, restaurants, and info points. This can give a more complete picture of the Park and a wider range of information for tourists and, on the other side, it can increase the value of the services already existing in the site that can be known and found easily and it can be an incentive for other stakeholders to open new services inside the Park. This feature can increase also the quality of life for the citizens because they can find near their home more services. At the end, it is possible to say that starting from the surveys it was possible to create a cognitive framework useful to do a project for the enhancement of the Archaeological Park (but in general, the system of knowledge is an important tool that can help to calibrate projects on the demands of people and spaces) and most of all, to create a management plan that allows to enhance and protect the heritage (Sgobbo & Basile, 2017; Tiboni & Rossetti, 2014; Tira et al., 2018). Using a web-map allows to implement participation of people such as citizens, city users and stakeholders and can help in spreading information and data about the assets involved. All these things go in the direction of creating the condition for a sustainable development of the territory (Fig. 9). Smart tourism is important because it can maintain an area alive and this can promote the creation of new services and the strengthening of the existing ones. It is possible to say that the wrong use, and most of it, the absence of functions in a building or in a place, is the first cause that produce degradation so, under this point of view, implementing tourism contribute to maintain the heritage of the city. This method can be the base for a process in which the problems and the weaknesses of a site are resolved in a holistic way. Smart tourism goes in the direction of the creation of a strong system of sustainable mobility so, knowing, at the beginning of the design phase, the main features of the streets and of the site is important to take the right choices. The process can be applied not only for the Park, but it can be used to define any type of area. The aim is to create a system that contains the main features of a part of the city that the Municipality wants to promote. GIS can help in the creation of this system of knowledge and it can be used to define the best strategy because it permits to link the wishes of the city users to the features of the area. In this context it is feasible to set the concept of sustainable mobility because it is necessary to put attention both to services and users. It is also necessary to link to this data all the information about the streets and about the existing services.

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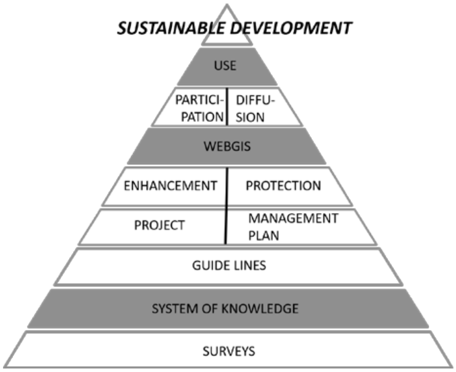

Fig. 9 The process from surveys to sustainable development

At the end it is feasible to say that resilience is strongly linked to knowledge. Using GIS allows to link and spread data about assets, so it is possible to promote a site and its monuments. This method is thought to simplify the fruition of Brescia urban core in the way to sensitize people to take care of the peculiarities of the area. This goes in the direction of resilience because sustainable development must involve the users and the way in which they enjoy the cultural heritage.

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AUTHOR'S PROFILE

Francesco Botticini, graduated in 2017 in Building Engineering and Architecture at University of Study of Brescia with a thesis about the enhancement and the protection of the cultural heritage of Brescia urban core. He is PhD student since November 2017 and his researches concern new ways for urban regeneration of cities with strong historical industrial vocation, namely he studies how to use GIS to create functional databases with the aim to develop a methodology to enhance the heritage.

Michele Pezzagno is an associate Professor in Town and Country Planning (SSD ICAR/20), Department of Civil engineering, architecture, land, environment and mathematics, University of Brescia. She had been expert in the EU Action COST C6 "Town and infrastructure quality for safety and urban quality for pedestrians" and she is involved in COST C15 "Improving relations between technical infrastructure and vegetation". She is member of the Phd school committee in "Places and times of the cities and territories" and of the Scientific committee of CeSCAm (Friendly City Study Center of the University of Brescia).

Michela Tiboni, since 2005 Associate Professor of Town planning at the University of Brescia (Italy), graduated in Civil Engineering, she obtained a PhD in Town planning at the Polytechnic of Milan (2003). Author of books, papers and other publications, her main fields of research are Land-use dynamics and environmental hazards, Evaluation of plan previews for a safe and sustainable town, Urban policies and techniques towards a safer town. She took part in many projects about Mobility safety as a management objective of urban transformation and Developing Urban Management and Safety, particularly working on the application of Geographic Information System (GIS), with attention to the monitoring of the effects of planning and traffic safety measures. Since 2013 she is Councillor for urban planning in the Municipality of Brescia

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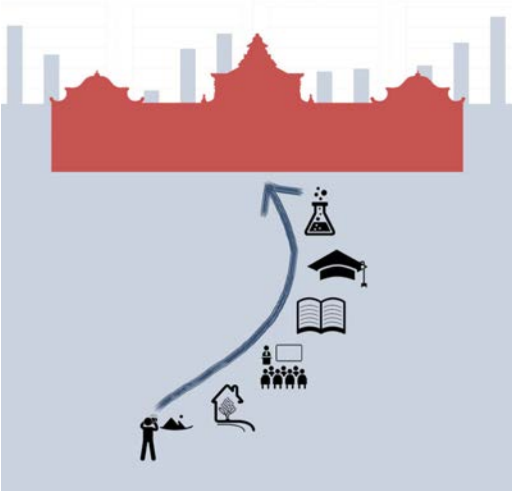

THE CHARTREUSE IN CALCI

APPLICATION OF A MULTI CRITERIA DECISION MAKING METHOD (MCDM) TO ITS FUNCTIONAL RECOVERY

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ABSTRACT

The Chartreuse in Calci is a IV century monument, home to the National Museum of the Chartreuse and the Natural History and Territory Museum. In the last years it has been suffering a sharp deterioration that requires an urgent functional and architectonic recovery. The question is to find a functional solution: scientifically proved; supporting the interests of the different stakeholders. Moreover, the presence of two managers, makes decisions difficult; respecting of the unique history vocations and the complex territorial context; economically efficient. A Multi-Criteria-Decision-Making (MCDM) method is applied to establish scientifically the most suitable solution among discrete alternatives. It is necessary to choose the parameters of the MCDM procedure - Objectives, Stakeholders, Alternatives and Criteria - by studying the results of the historical, urban and current state analysis. We identify 3 feasible alternatives: Museum Centre, Multifunctional Centre, and Convention Centre. They are evaluated through Criteria, which must ensure that all aspects that differentiate them are investigated and that Objectives are respected. Criteria are gathered into quantitative and qualitative ones, then weighed by the stakeholders in relation to their personal interests; lastly, we obtain an emerging solution for each stakeholder deriving by a scientific procedure. Although Multifunctional Centre is the solution that more rationally follows the objectives, and which achieves the greatest consensus among stakeholders, MCDM allows to elaborate smarter solutions by completing the winner one with some of the interesting characteristics adopted in the other alternatives.

KEYWORDS

MCDM; Scientific Procedure; Objectives; Stakeholders; Criteria; Chartreuse; Functional Solution; Architectonic Recovery

1 INTRODUCTION

The Chartreuse in Calci, Pisa, is an historical monumental dating back to the 14th century, currently home to the National Museum of the Chartreuse (NMC) and to the Natural History and Territory Museum (NHM) (Fig. 1).

Fig. 1 The Chartreuse in Calci

Since its foundation it has been showing a specific spatial and architectural articulation; according to the Cartusian statute, its spaces were divided into three parts (Fig. 2):

- "purgatory way", whose functions are connected with human life, consisting of guest quarters, agricultural, crafting and commercial production;
- "enlightening way", concerning cenobitic collective functions, which meant the passage between human and divine spaces;
- "unifying way", made of the spaces closest to the divine entity and spiritual life, including cells and courtyard.

Since its origins, the building shows the predisposition to contain different functions, whose different aims are translated into the different distributions of the spaces, into their forms and volumes.

The Chartreuse has always performed an important task at a territorial level, not only as a spiritual guide, but also because it became a big farm around the second half of XVIII century, under the Prior Giuseppe Alfonso Maggi; this business was supported by Leopoldo I the Tuscan Grand Duke, willing to overcome the economic crisis and let it succeeded in reaching a predominance position and influence on the surrounding territory, up to the religious suppressions (1804). The building transformative interventions were connected to various architectural integrations in the XVII century's end style, such as the symmetrical façade illusion and the perspective views into gardens or inside the new corridors. In conclusion, history witnesses the presence of strong vocations connected to the Cartusian rules as well as to the territory needs. Over the last few years, the reduction in funding for its maintenance has caused a sharp deterioration of the Chartreuse (Gioli, 2015). To attract funding, it is first necessary to reactivate people interest in the building and in the activities that it offers. A functional recovery is required to ensure a proper use and a proper maintenance.

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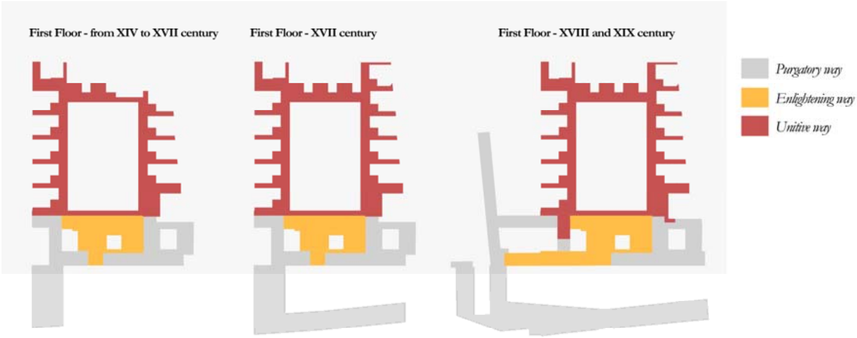

Fig. 2 The three "ways" over time

A mathematical approach has been applied to establish the most suitable functional solution; in particular, a Multi-Criteria-Decision-Making method (MCDM), that has got the aim to make a scientific analysis to choose among discrete alternatives (Paolucci, 2000), by reaching a solution that can achieve as much consensus as possible. Indeed, it has got a complex management situation, because the spaces are spared between two different managing institutions: Ministero Beni Ambientali Culturali e del Turismo (MiBACT) related to the Superintendence and Ministero Istruzione Università e Ricerca (MiUR) to the University; moreover, in the future, NHM, which was intertemporally developed by adapting progressively the old spaces of the Chartreuse when it needed, couldn't contain new collections inside the spaces currently to its disposition.

The historical building is surrounded by other actors as well, among which the Public Administration, the external users and Calci inhabitants. The question is to find a functional solution which is rational, scientifically proved and, at the same time, supports the interests of the various stakeholders, it respects the unique history vocations and the complex territorial context, it is economically efficient, allowing to the Chartreuse to cheer up its dramatic condition without losing its identity, but rather enhancing it.

2 WHY A MULTI-CRITERIA-DECISION-MAKING METHOD

Multi-Criteria-Decision-Making (MCDM) can offer a formal methodology to deal with complex decision problems and with the difficulty in identifying good alternatives, taking into account multiple objectives and stakeholders values. MCDM methods are used to make a comparative assessment of alternative projects or heterogeneous measures. These methods allow several criteria to be taken into account simultaneously in a complex situation and they are designed to help decision makers to integrate the different options […].

(Ferretti et al., 2014). The choice of the method used for the research, derives from the aim to apply a mathematical procedure that can guide a decision-making process characterized by high complexity such as the choice of functions to be identified in Calci Chartreuse. In fact, not only the characteristics of the architectural good and its historical vocations create strong constraints on the new functions: these ones have to meet the economic needs and satisfy complex management system as well, in fact, as already mentioned, the Chartreuse's spaces are currently occupied by two museums, NMC and NHM (which needs more spaces), respectively managed by MiBACT and MiUR (Fig. 3). The goal is not to achieve a unique solution, since it is impossible to find a perfect one, but the one that more rationally approaches the attainment of the set goals.

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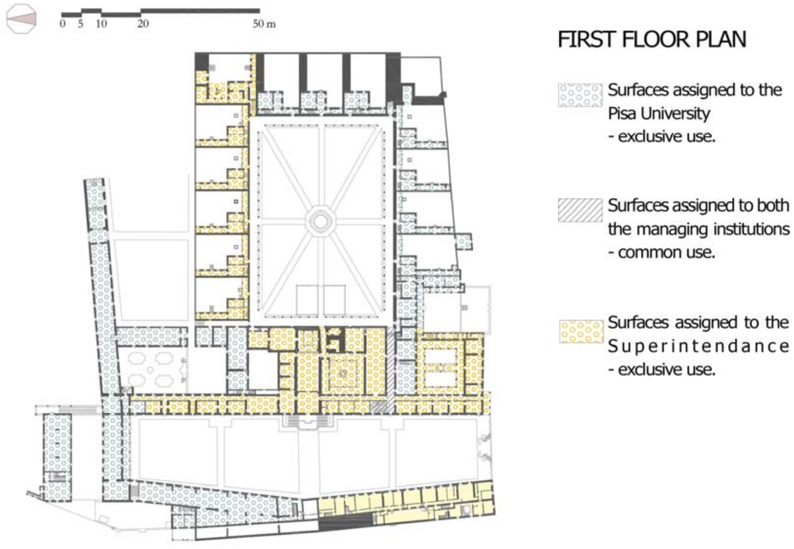

Fig. 3 The Chartreuse's surfaces spared between the two managing institutions

3 FROM THE ANALISYS TO THE CHOICHES

To establish the alternatives, we followed a specific method, starting with the development of a multiple analysis:

- historical-critical one, by taking advantage of texts and iconographic archival sources;
- socio-territorial one, by studying historical iconographic urban tools, territorial urban planning tools, and local ones;
- the current state situation inside and around the building; we studied the actual functions, the accessibility and the routes of the two museums.

The historical-critical analysis brought to light the reasons that led to the compositional transformations of Chartreuse over time and the functions that have historically characterized the building (Manghi, 1911).

These can be gathered into four groups (Fig. 4):

- 1: hospitality and guest quarters;
- 2: agriculture, craftsmanship and commerce;
- 3: residence, meditation and spirituality, study and individual work;
- 4: artistic, architectonic and landscape - environmental values.

The territorial analysis allowed to study the relationships between the Chartreuse and the surrounding territory over time, and to identify the modern functions linked with the evocative ones. The most influential territory for Calci is composed by Pisa and Lucca cities and by the typical urban settlement system formed by the rural places at foothills, such as Vicopisano, Buti, Cascina, San Giuliano and Calci itself, linked each other by a viability around the Pisani Mountains (Fig. 5).

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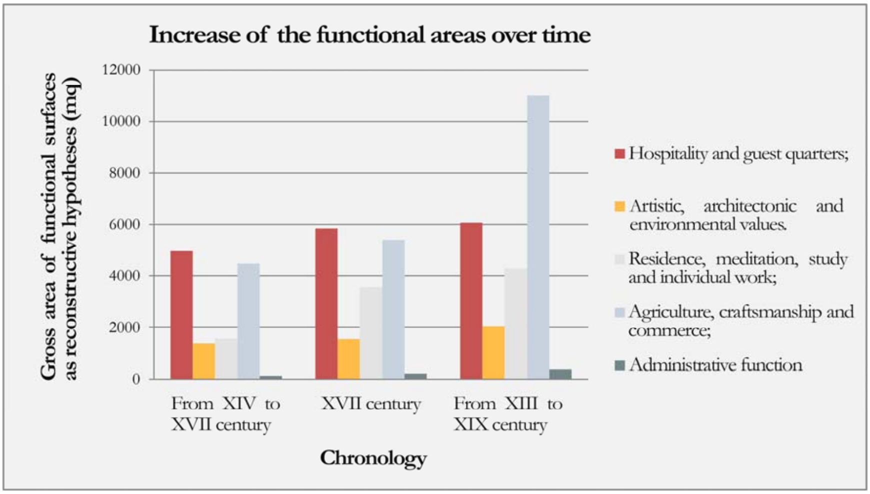

Fig. 4 The increase of the functional areas over time

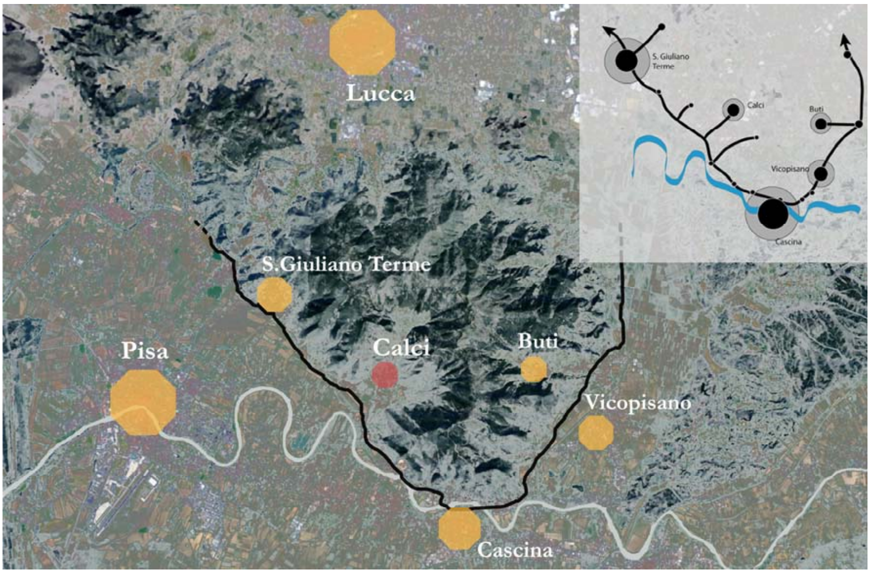

Fig. 5 The most influential territory for Calci

The design idea is the one to link the Chartreuse new or renovate functions to the territory modern needs, in order to create something useful but not losing the historical vocation identity. Through the analysis of local urban planning tools, territorial constraints and potential interest for design purposes have been studied. For example, the presence of environmental constraint emerged, or the observation of abandoned quarries make us reflect on how these elements could be reused and linked with new potential function inside the Chartreuse. The third step was defined by studying the current state situation inside and around the building, involving

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the accessibility to the spaces and the routes along the two museums present in the complex: the NMC and the NHM (Barbuti & Landini, 2009). This analysis has proved that so many spaces inside the building can't be reached by wheelchair users because of the presence of architectural barriers, such as monumental stairs, ancient service stairs or tight corridors with no spaces for manoeuvre. For instance, the whole south area at the second floor of the building isn't reachable by them; also the courtyard is difficult to reach because the Chartreuse is built along a sloping land. The analysis of the routes inside the two museums has proved the presence of some criticalities as well. Here is an example: when you walk along the Whale Gallery (HNM), placed into the ancient XVIII century granary, you have to turn yourself and walk it all again to exit. This is a prove of the non-linear museum path, which can be solved if we restore the balcony on the corner with the façade, making it feasible (Fig. 6).

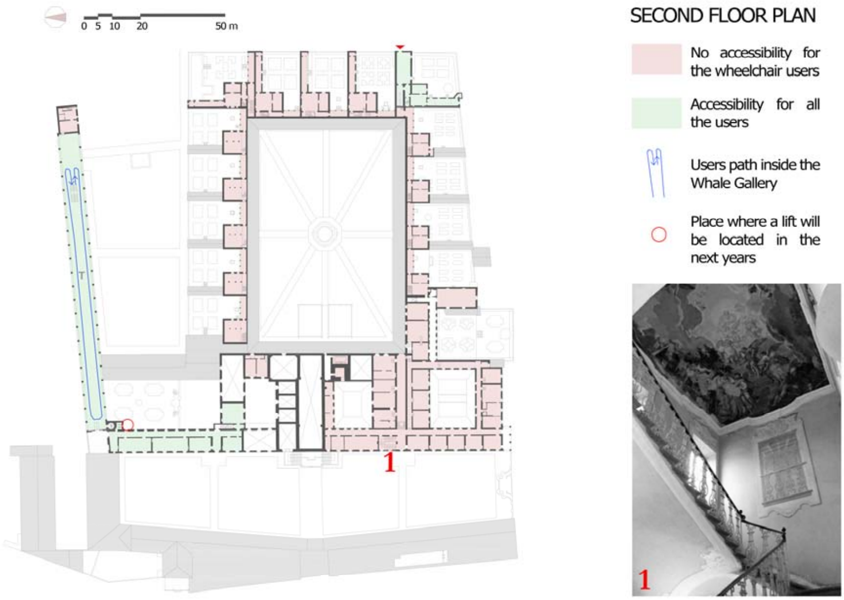

Fig. 6 Study on accessibility and museum paths

Then we studied the results of the analysis by bringing out potential and criticality, that let us identify the objectives to be achieved in the functional solution and to develop action strategies in order to pursue them. These last, conveniently combined with each other, allow to reach different design solutions that consider the future needs of the already present activities, in different ways. We can identify potentials and criticalities, then look for objectives and action strategies. For example, we identify as a criticality the insufficient area for car parking suitable to big flows, but we consider as a potentiality many wild green spaces close to the Chartreuse, which might be used as parking, being careful to respect the environment.

So we can establish this following objectives:

- to improve external accessibility for the different transport levels;
- to create new car parks.

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The action strategies defined to reach these objectives are:

- to design a car park system located partially along the border of some green spaces and partially into a basement floor, to limit visual impact;
- to design a parking system for buses.

The action strategies, derived from the analysis, allowed to define a single external masterplan but three possible different functional solutions, that try to solve in different ways the future lack of spaces for the NHM. These solutions foresee:

- 1: the complete sit-in of the Chartreuse spaces by the NHM and a conveniently integration with the monumental rooms;
- 2: a Multifunctional Centre, by selecting the collections of the NHM to be left on site;
- 3: the complete elimination of the NHM and its replacement with a Convention Centre.

4 THE PARAMETERS OF MCDM ANALISYS

By studying the results of the analysis, it was possible to identify the fundamental parameters of the MCDM procedure (Formisano et al., 2015): objectives, decision makers, alternatives and evaluation criteria.

- OBJECTIVES: the aims to be reached into the design projects;
- DECISION MAKERS, or "stakeholders": the actors involved in the decisional process, interested in the evaluation of the design choices;
- ALTERNATIVES: the objects of the evaluation process, that are the possible discrete solutions deriving from the analysis made;
- EVALUATION CRITERIA, on the base of which stakeholders evaluate the alternatives. Criteria are rules or judgements established for testing the desirability of the alternatives, evaluating the positive or negative impact of the criteria on the alternatives themselves.

MCDM method involves directly the stakeholders because, on the base of their personal interests on the project, these lasts have to judge subjectively the criteria, by appointing to each of them a "weigh". The evaluation scale from which stakeholder can choose the weighs is the same for all of them. The result of the analysis is defined on the base of an objective step first, and then considering the weighs assigned by each stakeholder. So, at the end of the analysis, we'll have, for each stakeholder, a final result with a emergent alternative. The role of the designer is to choose the number of the parameters (objectives, decision makers, alternatives and criteria), after identifying them on the basis of the preliminary analysis done. Obviously if the number of elements inserted increases, the grade of accuracy and rationality of the analysis will be higher. In this project we may consider the idea of inserting other elements so that a review could be made; as designers we believe to have reached a certain degree of accuracy.

OBJECTIVES to reach (Fig. 7); here below there are some of them:

- preserving the building's historical identity and vocations;
- working so that Chartreuse acquires importance at a wide territorial scale;
- maximizing the use of existing structures.

DECISION MAKERS involved in the process of choice:

- University of Pisa;
- Superintendence of Archaeology, Fine Arts and Landscape for Pisa and Livorno Cities;
- Public Administration;

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- Calci inhabitants;
- External users and visitors;
- Financiers willing to invest in new business for the Chartreuse.

ALTERNATIVES, that are the design solutions:

- 1: Museum Centre, only one function with five big exposition areas;
- 2: Multifunctional Centre, which integrates these activities: NHM, NMC, Reserve Museum for scholars, Research Laboratory, Guest Houses linked with a Widespread Hotel, Interactive Agricultural Park;
- 3: Convention Centre, including flexible areas for exhibitions, conventions, workshops.

CRITERIA with whom stakeholders evaluate the alternatives. Below there are some of the criteria and variables used for measurement:

- possibility to visit the NHM during the constructions;
- respect for vocations and historical identity;
- profitability;
- interference among the various activities;
- attraction of financiers;

OBJECTIVES	
Preserving the building's historical identity and vocations.	Maximizing inner accessibility for the various categories of users.
Reason: these ones were developed from the origins, as observed in the historical analysis.	Reason: there are too many architectural barriers!
Working so that Chartreuse acquires importance at a wide territorial scale.	To find compromises between the new structural and design solutions and the historical values.
Reason: it has been losing this own characteristic in the last centuries.	Reason: the area is subject to architectural and environmentally protective restrictions, as studied in the preliminary phase.
Maximizing the use of existing structures and economical potentialities.	Improving territorial accessibility.
Reason: the lived spaces lasts more over time!	Reason: there are some criticalities about it, as observed in the territorial analysis.
To guarantee the safeguard and the promotion of the historical and artistic sources belonging to the Chartreuse and to the surrounding territory.	
Reason: this important characteristic risks to be loosen due to the degradation and the lack of consideration and funds destined to it.	

Fig. 7 The objectives chosen for the MCDM analysis

5 THE DETERMINATION AND EVALUATION OF THE CRITERIA

The determination and measurement of the criteria is the most complex study, as they must ensure that all aspects that differentiate alternatives are investigated (Keeney & Raiffa, 1993). For this reason, a number of themes have been identified to gather the criteria; a first grouping divides them in relation to the construction phase or to the management phase of the reused building. Subsequently, as regards the former, they have

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been identified on the base of costs, times, new constructions and the possibility to visit the existing Museums during the construction site. Instead, in relation to the latter phase we considered these sub-categories: Safety, Welfare, Availability, Look, Management, Territorial integration and Environmental protection. (Figg. 8, 9, 10, 11, 12)

CONSTRUCTION PHASE

C1) Costs for the accommodation of open spaces (cultivated fields, auditorium).	Qualitative
C2) Operating times.	
C2.1) Interventions on furnishing elements and on exhibited objects.	
C2.1.1) How many elements should be moved elsewhere during the construction phase (how many mq should need for this operation).	Measurable: mq
C2.1.2) How many new elements must be inserted (the furniture of the general services is considered a constant).	Qualitative
C3) Possibility of visiting the MSN during the move (total, partial, null).	Qualitative
C4) Interventions related to the construction of new sanitary facilities and the passage of hydraulic pipes; in the central body of the monastery they are considered a constant.	Measurable: n° new sanitary facilities
C4.1) In the cells of the Carthusian Fathers.	
C4.2) In the "low house" and in the "gallery".	
C5) Interventions related to the construction of new plumbing and gas systems, and to the passage of pipes for kitchens (cafeterias, food outlets).	Measurable: n° new refreshment points

Fig. 8 Criteria: Construction Phase

MANAGEMENT PHASE - G1, G2

G1) Criteria related to security	
G1.1) Fire load, which depends on the materials present, on the prevalence of which classes of reaction to fire, and on the quantity of large or small pieces.	Qualitative
G1.2) Possible presence of explosive substances.	Qualitative
G1.3) Possibility of vibrations on the structure due to the acoustic noise.	Qualitative
G1.4) Increase of the variable load on the structure.	Qualitative
G2) Criteria related to well-being	
G2.1) Acoustic disorder (pejorative situation).	
G2.1.1) Operation of new audiovisual or acoustic installations, scenic.	Measurable: n° hours per day
G2.1.2) Quantity of new audiovisual or acoustic installations, scenic.	Measurable: mq
G2.1.3) Frequency of use of microphones.	Qualitative
G2.2) Emission of harmful substances or unpleasant odors, based on how many laboratories there are.	Qualitative
G2.3) Activation of natural ventilation (openings to the outside).	Qualitative
G2.4) Need to make the environment comfortable depending on how much users have to stay.	Qualitative

Fig. 9 Criteria: Management Phase – G1, G2

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MANAGEMENT PHASE - G3, G4

Criterion	Measure
G3) Criteria related to usability	
G3.1) Estimated amount of users (the environment is considered as less usable as many users are expected).	
G3.1.1) Regular users (expected on daily average in the total of all environments).	Measurable: estimated number of people
G3.1.2) Occasional users (expected on average during exceptional organized events).	
G3.2) Interferences between the paths of the various activities: problems related to the nodes in which different functions paths cross each other.	Qualitative
G3.3) Difficulty of usability of outdoor spaces, linked to the frost problem.	Qualitative
G3.4) Number of parking areas sufficient for the expected turnout	Measurable: mq
G3.5) Usability of road routes following the increase in traffic (coaches, schools and companies are not considered because they are not considered to increase traffic). The evaluation is carried out based on the expected turnout. It is believed that the environment is more usable as the traffic reduce.	Qualitative
G3.5.1) Weekdays.	
G3.5.2) Holidays.	
G4) Criteria related to appearance	
G4.1) Respect of historical vocations (study, research, guest - house, artistic value and landscape value); production, commerce and reception -refreshments are a constant.	Measurable: n° evocation functions taken into consideration
G4.2) Value added to the monumental zone (integration into the overall system).	
G4.2.1) Permanent exhibitions.	Measurable: mq
G4.2.2) Temporary exhibitions.	Measurable: mq
G4.3) Enhancement of panoramic views (symbolic integration with internal functions).	Qualitative
G4.4) Increase in agricultural productivity.	Measurable: mq

Fig. 10 Criteria: Management Phase – G3, G4

The quantification of the criteria was developed in two separate moments. At first it was necessary to distinguish quantitative criteria, i.e. scientifically measurable, from qualitative criteria. The latter are evaluable by judging their impact on the alternatives by assigning scores to a scale from 0 to ± 1 in relation to the greater or lesser influence on the alternative considered. Positive ones produce benefits, negative ones worsening. For quantitative criteria it is necessary to indicate the value of the measure. Quantitative criteria and qualitative ones are evidently inconsistent in terms of typology and units of measurement, therefore it is necessary to make a normalization that makes them all comparable within the same range, chosen between 0 and ± 1. By calling a, b, and c the criteria values for the three alternatives (taken all in absolute value), the normalized values will be:

$$d = (a\text{-MIN }(a, b, c)) / (\text{MAX }(a, b, c) - \text{MIN }(a, b, c)$$
$$e = (b\text{-MIN }(a, b, c)) / (\text{MAX }(a, b, c) - \text{MIN }(a, b, c)$$
$$f = (c\text{-MIN }(a, b, c)) / (\text{MAX }(a, b, c) - \text{MIN }(a, b, c)$$

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MANAGEMENT PHASE - G5, G6

G5) Management criteria	
G5.1) Single or different manager.	
G5.2) Maintenance.	
G5.2.1) Diversified times of maintenance of the various types of elements contained in the Chartreuse.	Qualitative
G5.2.2) Delicate objects to be maintained at a greater frequency.	Qualitative
G5.3) Reduction of common spaces between several managers (the reduction of common spaces is seen as an element of improvement since it avoids problems of conflict).	Measurable: mq
G5.4) Profitability - estimate of total revenues (services and interactive agricultural activities considered a constant).	Measurable: estimated value of the earnings per year
G5.5) Possibility to receive funding from external operators (sponsors or investors for some activities), interested in new functions.	Qualitative
G5.6) Job offer.	Measurable: n° people for one day
G6) Criteria related to integration	
G6.1) Use of disused territorial elements (historical buildings, industrial buildings, quarries).	
G6.1.1) For the widespread museum.	Measurable: mq
G6.1.2) For the widespread hotel. It is considered that the involvement of other structures allows, beyond their building and territorial recovery, a greater circulation of money, therefore an improving condition.	Qualitative

Fig. 11 Criteria: Management Phase – G5, G6

At this point it is necessary to multiply d, e, f for (-1) when criteria are expression of costs and worsening, so as to differentiate them from positive ones, that relate to mitigations and benefits; we would have find an evaluation matrix, made of three columns (the alternatives), each of which has got a value for each criterium, that goes from -1 to +1. Realistically, not all criteria have the same relevance, so it is necessary to calibrate the system by appointing to them a weigh, within the range from 1 to 5, taking into account economics, logics and useful aspects; so we obtain the baseline weigh vector.

Then the decision-makers can draw up a scale of importance for the criteria, exposing their subjective interests, by drafting a vector containing their own weighs for each criterion (Fig. 14). We obtained six decision matrices, each correspondent to a stakeholder. The emerging alternative for each stakeholder derives by performing the arithmetic sum of the numeric components of the vectors corresponding to the alternatives and comparing them to each other.

6 ANALISYS OF THE RESULTS AND COMPROMISE CONSIDERATIONS

As it could have been expected, the chosen alternative was not the same for every stakeholder because of their different interests in the building (Fig. 13).

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MANAGEMENT PHASE - G7, G8

G7) Criteria related to environmental protection	
G7.1) Amount of parking spaces required based on the expected external user attendance.	Measurable: mq
G7.2) Amount of parking spaces necessary for the employees and the administration of the Chartreuse.	Qualitative
G7.3) Increase in traffic; coaches, schools and companies are not considered. The evaluation is carried out based on the expected turnout. The increase in traffic is seen as a critical issue for environmental pollution.	Qualitative
G7.3.1) Weekdays.	
G7.3.2) Holidays.	
G7.4) Energy requirements.	
G7.4.1) Permanent night lighting.	Measurable: mq
G7.4.2) Variable night lighting.	Measurable: mq
G7.4.3) Energy technical installations to keep the structures active.	Qualitative
G7.5) Environmental impact of external installations.	Measurable: mq
G7.6) Increase of green areas made cultivable; this criterion takes into account the fact that agricultural techniques make use of pesticides and materials that sometimes generate environmental impact.	Measurable: mq
G8) Other	
G8.1) Interest of users extended over time (estimate of the return time of the same users in the structure).	
G8.1.1) Children and young people.	Qualitative
G8.1.2) Adults.	Qualitative

Fig. 12 Criteria: Management Phase – G7, G8

The MCDM method can help us to control which are the parameters that lead to the results and to find the main problems which influenced the stakeholders choices for each alternative (by observing the worse values). So, we can integrate the various alternatives among them, enhancing the positive aspects, allowing to achieve a greater sharing among decision makers.

The Superintendency is of course the most important in order to ensure the respect of the monumental historical asset.

Based on this, we can start with discarding the alternative 3, that is the Convention Centre, because it results in a negative value for the Superintendency, as an index of general worsening; the reason for this result can be found by observing the weights that this stakeholder had attributed to the various criteria, from which, rather than the other alternatives, a greater distance from the historical vocations emerges along with a greater risk linked to artistic protection and environmental impact, due also to an excessive visitors attendance.

Between the two alternatives, the Multifunctional Centre is the one that benefits from the greatest consensus among decision-makers, except from the financial operator, due to the lack of flexibility of activities organized in the various spaces, which, on the contrary, was the main characteristic of the Convention Centre.

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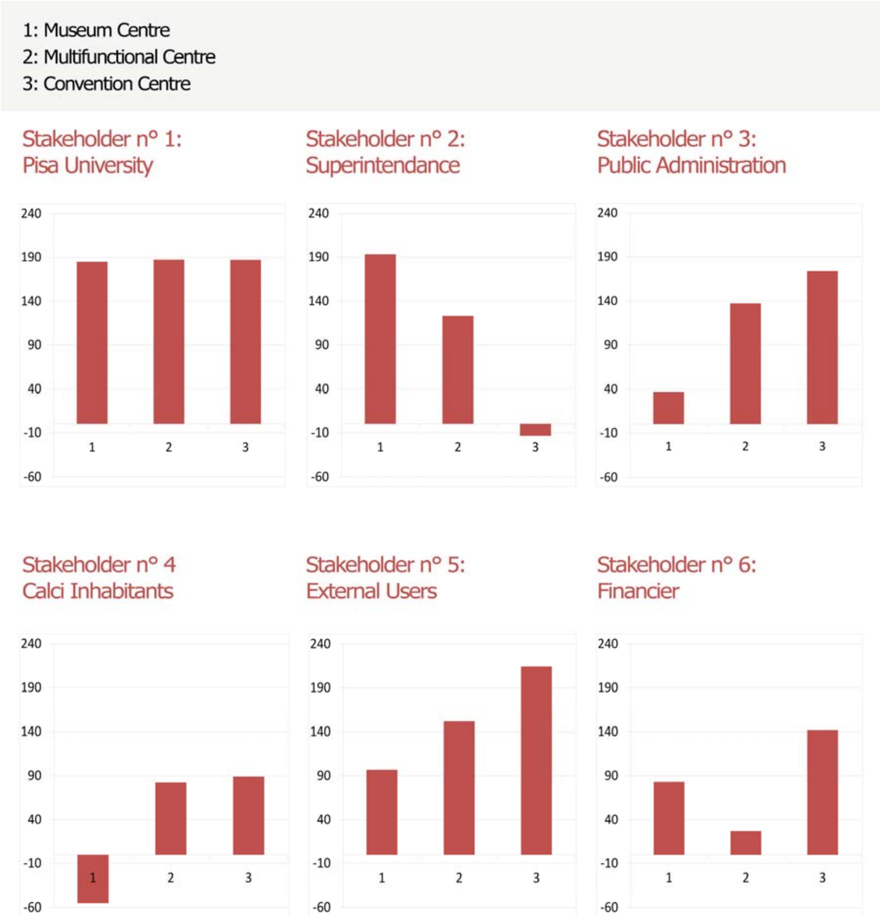

Fig.13 The different results of the MCDM analysis for each stakeholder

By checking the criterion or the groups of criteria most favoured by the different actors, it is possible to elaborate compromise considerations and to modify some aspects of the chosen solution to make it smarter. For example, some spaces in the Multifunctional Centre, designed for a single function, may become more flexible, in order to respect the historical vocations, but to attract more economic operators. In the same way, the hypothesis of a Widespread museum - hotel on the Pisani Mounts may be enhanced because it can economically involve the territory inhabitants and it can intrigue external users. (Fig. 14).

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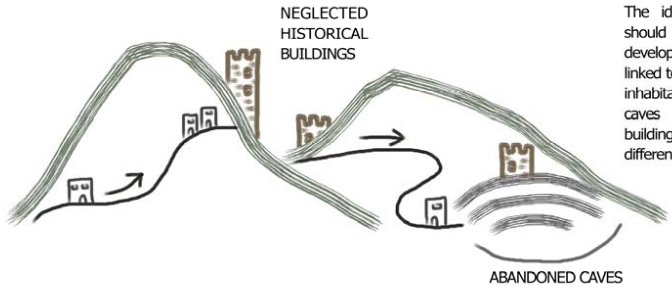

Fig. 14 The widespread Museum – hotel on Pisani Mounts

7 CONCLUSIONS

In conclusion, the application of a multi-criteria method in the specific case allows to find a compromise result and reach a shared decision. The ability of the method to control the involved variables allows also to guide design choices to solutions that are more responsive to the stakeholder's wishes. The future developments should deepen the techniques of quantifying variables, of assigning weigh to them, for example using the Pairs Comparison Method (Saaty, 1988), and of identifying the emerging alternative by using ELECTRE 3 method (Roy, 1985) instead of the simple arithmetic sum. A better grade of accuracy may be reached also by gathering the criteria in order to distinguish not only the construction phase from the management one, but also the management brief time from the management long time, in which the criteria concerning monitoring and maintenance are inserted (such as the monitoring costs, the possibility of the interventions reversibility or the possibility of conservative or changing interventions in the future).

Finally, we can affirm that this methodology can be effectively used for other architectural and territorial complex decisions.

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SPATIAL DATA INFRASTRUCTURE IN HISTORICAL CONTEXTS

THE CASE STUDY OF MATERA

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ABSTRACT

This contribution describes the activities for the design and development of geographic databases systems to support decision making in planning processes. In particular way, these activities are aimed to creating a prototype information system for the recovery, reuse and management a part of the urban-building fabric of the "Sassi" District of the Municipality of Matera (Italy), Unesco site and European Capital of Culture for 2019. The general goal is to realize, in an area of the municipality characterized by an architectural and identity heritage of inestimable value, a "spatial data infrastructure" (SDI) relating to the minimum training requirements for the preparation of cognitive, interpretative and management equipment organized according to standardized procedures. The proposed methodological approach promotes a model based on the integration of different kinds of databases and on their interoperability, in coherence with the community strategies for the development of the digital economy and culture (ICT). The concept of interoperability is applied on more levels: from the technological one, regarding the capability of ICT systems to exchange information based on shared rules, to the semantic one, related to the information reuse without losing its real meaning, as defined by the European Interoperability Framework model (EIF). The present work, in brief, refers to the prospect of reuse and migration of the SDI on a platform developed on a web-based GIS system, in order to facilitate the carrying out of activities related to different spheres (town planning, toponymy, building dossier, etc.).

KEYWORDS

Urban planning; Historical contexts; Cultural heritage; Interoperability; SDI; ICT; Open Data; Geoinformatics; Linked Data

1 INTRODUCTION

In 1999 Basilicata Region has approved its spatial planning law on the use and governance of the territory (LUR 23/1999), an innovative act with reference to some topics to the attention of the scientific and disciplinary debate at that time; among others the production of the Geografic Informatio System (GIS) that "represents the fundamental cognitive reference in the definition of *the Territorial and Urban planning tools and of the economic-territorial planning*" (art. 41). In reality, the use of these tools isn't yet widespread and is limited, in most cases, only to graphical representation of municipal level plan drawings. Although since few years some progress has been made to cope with this criticality (for example the realization of DBGT of Regione Basilicata), there is still considerable potential to improve further services offered by Public Administrations, through a complete integration between geographical data, automation of standardized procedures, a better use of information sources, the release in open format of public data. To understand if and how the use of geographical information systems can help improve territorial governance, the work illustrates the activities developed for a part of "Sassi" District of the Municipality of Matera (Italy), Unesco site[1] and European Capital of Culture for 2019. The activities are aimed at creating a prototype information system for the recovery, reuse and management of the historical building heritage, through the development and structuring of geographic databases and IT systems, in order to implement a decision support tool in urban planning processes. In this sense, particular attention was paid to the development of standardized methodologies and procedures able to effectively respond to three sets of objectives: create a knowledge base on which to base the strategies for the recovery and management of urban-building heritage of Sassi District; support the reuse and integration between different geographical databases, or rather guarantee their interoperability; extend the prototype application also in other contexts of the city. This work, starting from the description of the SDI objectives, highlights the methodological and procedural approaches developed for the realization of the SIT prototype, analyzes the main databases of data processed and the fields involved in the experimentation.

2 INNOVATIONS IN THE URBAN PRACTICE

2.1 FOREWORD

The goals assumed in the activities of the Member States of the European Community for the digitalization of their public administrations, refer to the following aspects: save time, reduce costs, increase transparency, improve both the quality of data and the delivery of public services. In this scenario, the concept of interoperability of spatial data and services connected to them, or rather the possibility of exchanging and using information available from an administration in an integrated manner, assumes a fundamental importance to promote digital transformation of the PA; it's considered, therefore, that the sharing and reuse of databases through the implementation of the SDI can contribute to the implementation of EU policies and activities.

[1] "The site area - during the seventeenth session of the World Heritage Committee, held in Cartagena (Colombia), from 6 to 11 December 1993 - has been included in the World Heritage list with the following motivation: The whole of the Sassi and the Archaeological and Natural Park of the Rupestrian Churches of Matera constitutes a unique testimony of human activity. The exceptional universal value derives from the symbiosis between its cultural and natural characteristics " (UNESCO Sassi Management Plan 2014-2019).

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The work developed promotes a methodological approach based essentially on three principles: "organizational" interoperability, that is the way in which the work processes have been aligned with commonly codified modeling techniques; "semantic" interoperability, aimed at ensuring that the format and meaning of the exchanged data are maintained and understood during all working processes; technical interoperability, that is documents, applications and infrastructures that allow the connection between systems and services (GIS, formal technical specifications).

2.2 METHODOLOGICAL APPROACH

The proposed methodological approach promotes a model based on the integration of different "datasets" and on their interoperability. To pursue this general goal, the work has developed and tested techniques and methods - automatic or semi-automatic - which have had as their object the realization of new knowledge starting from a certain number of "geolocalized" data. An important aspect of the work, indeed, is represented by the possibility of using the principle of "geolocation" as an unifying element of the information that concern the scope of the experimentation. The assumption is that "*the accurate knowledge of the positioning of an asset contributes to its maintenance, conservation and maximum usability*" (AMFM, 2014). To ensure this condition, it was necessary to support the declinations of the concept of interoperability referred to above, that one concerning the topological question, that is the respect of the geometric consistency in the spatial relations between the geometries. This operation was necessary in the development of the work, as some geographical data elaborated and implemented in the SDI are derived from datasets produced natively with different spatial resolutions (different nominal scale).

3 SDI AND DATA BASES FRAMEWORK

As in other regional realities, among which Lombardy and Emilia Romagna regions, recently also the Basilicata Region has a topographic database (DBGT), considered an instrument *"indispensable for economic planning and for planning and design of territorial urban development interventions"* (Cartographic Portal of the Basilicata Region, 2018). And it's precisely starting from this tool available on the regional portal, that the SDI has been structured (Fig. 1), aimed at promoting the collection, coordination and integration of heterogeneous information flows with the DBGT. The effort made in the development of SDI aims to combine, through computer technologies and automated procedures, an important amount of spatial data with other information from specific sectors. In this sense some basic data - re-projected into the DBGT reference system (WGS 84 – UTM 33N) and attributable to some thematic areas among which are recalled the necessary bases for contextualizing the information (topographical bases, orthophotos, DBGT Basilicata Region, aerophotogrammetry), information from the General Recovery Previsions (PdR) of Sassi District, toponymy and house numbers for geocoding, information regarding the road network (driveway and pedestrian) and the built environment (survey of the building units[2]), the cadastral bases and identification and income data of real estate (lands and buildings), census data (ISTAT), the open data catalog of the

[2] The information implemented in the SDI refers to the significant relief activities on building heritage of Sassi District through a "standard form", carried out by the students of the School of Architecture in Matera, University of Basilicata.

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Municipality of Matera – have been relevant for geolocation, standardization and systemisation[3] of information in the prototype of the information system.

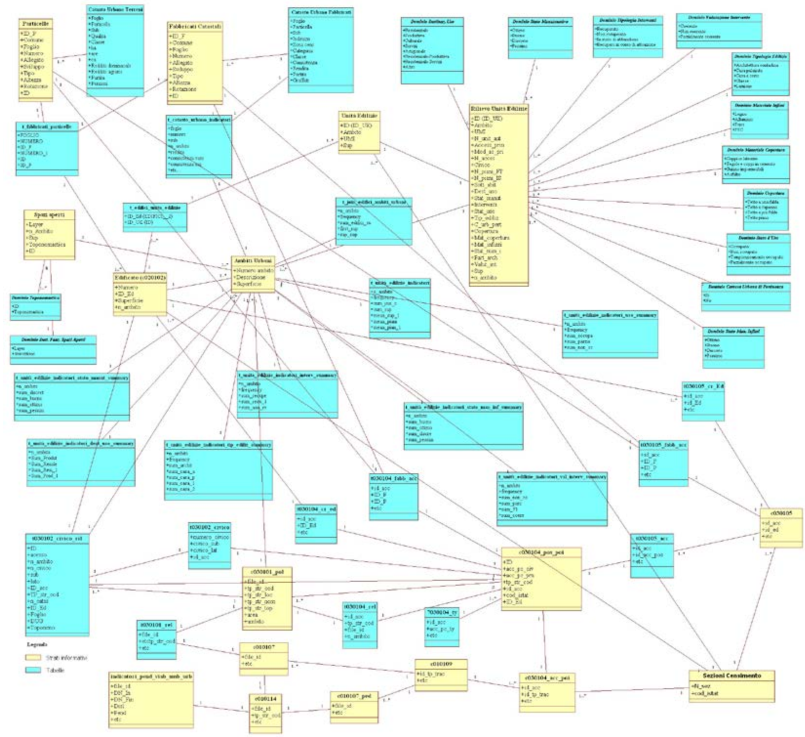

Fig. 1 Physical model of the SDI.

The architecture of the SDI was implemented in the GIS environment. In fact, it is believed that the design, implementation and use of the SIT can favor a better management of the complex cognitive framework that it's necessary to prepare both for the correct management of the historical building heritage, and for a better evaluation and definition of the project choices compared to the definition of an adequate discipline for the recovery and enhancement of the historical building heritage of the Sassi.

In structuring the geodatabase, the reference to technical acts aimed at improving fruition, the exchange and use of databases has represented an important aspect. Particularly significant, in this sense, was the 2011 Decree that defines the technical rules for training, content, documentation and usability of geotopographic databases, organized according to specific rules both in terms of structure and content; these specifications are contained in the "Catalog of spatial data" (attachment 1) and in the document

[3] Database design technique by which data redundancy is eliminated in order to avoid anomalies in their consistency following insertion, cancellation or modification operations.

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"Rules for interpreting content specifications for geotopographic databases" (attachment 2), that constitute the reference documents for the public administrations for the collection and management of the territorial data of own competence. In particular, the catalog identifies the territorial data that represent and describe the territory in the main natural and anthropic aspects, organized in Layers, Themes and Classes, with the relationships and the constraints between the data themselves. The reference structure is constituted by the "class" that defines the representation of a specific typology of territorial objects (property, data structure, rules of acquisition, structuring and relationship with other objects). The territorial data, described in the catalog, correspond to the DBGT of the Basilicata Region, which represented, in the development of the SDI, the first information nucleus to be integrated with the other thematic DBs acquired. The same structure was also maintained in the SIT prototype developed for some sectors of the current Recovery Plan of the Sassi District. An important activity, in this sense, turned out to be the alignment and standardization of the data with the indications contained in the aforementioned decree; an example of this activity is represented in the conceptual model shown in the following figure, referring to some classes of territorial objects revised through automated or semi-automatic procedures.

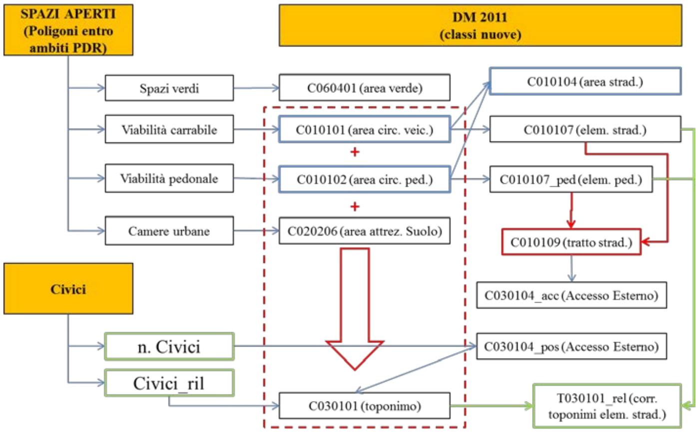

Fig. 2 Conceptual model of alignment of some SDI classes

In the past the greatest efforts in the geographical information sector have been concentrated on the creation of territorial databases. Nowadays, considering the dissemination of these tools, the emerging problem is represented by the creation of homogeneous and conceptually and geometrically coherent archives; reusing existing geographic information for purposes not foreseen at the time of their production makes them available for very useful updating processes. Referring to the objectives assumed in the development of the SDI, we proceeded, on the basis of a preliminary phase to investigate the existing data bases, to prepare a synoptic framework of the minimum information requirements for the preparation of the cognitive structures. The SDI consists of a total of about 120 classes (between information layers and external report tables), which represent the basic data, the intermediate and final elaborations, the thematic indicators developed for the realization of the cognitive and interpretative structures (26 macro indicators). About the assumption placed at the base of the experimentation, or rather the importance of the "position" of territorial objects, the elaborations performed to align the data bases inherent to the information layers of the DBGT road network and those of toponymy (not populated classes in the DBGT) turned out to be among

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the most interesting procedures developed; thanks to the applied methodologies, in fact, it was possible to associate with each cartographic road element (driveway and/or pedestrian) the related toponym. The figures below summarize the methodological approach used (Fig. 3) and the procedures implemented to pursue the objectives assumed (Fig. 4).

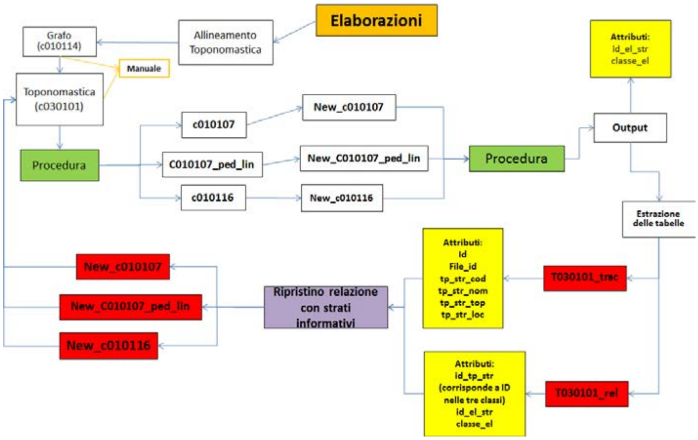

Fig. 3 Conceptual model of the alignment procedure of some SDI classes

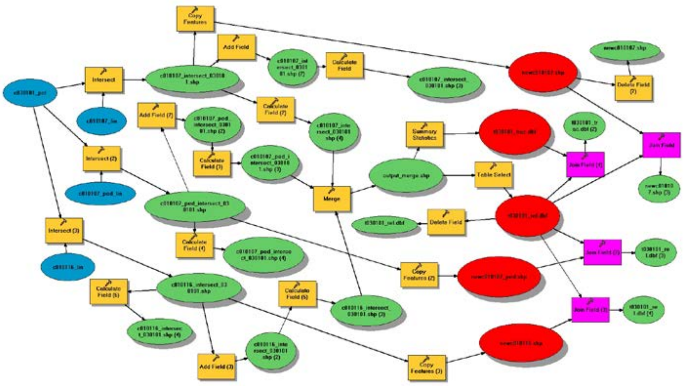

Fig. 4 Procedure for the alignment of some SDI classes (Model Builder)

Among the information levels that constitute the SDI, particular attention was paid to the normalization of the issues related to the management of the toponymy and the civic numbers acquired on the "Open Data" platform of the Municipality of Matera, key elements both for the search of geographical objects and for the connection with other databases, among which are those related to buildings, to municipal registry office (aspect not debated within the SDI), to data of a statistical nature, etc. In particular way, the procedures developed were aimed at defining, for the scope of the experimentation, the organization of the municipal street map and its toponymy. An aspect considered interesting, for the purposes of this work, is represented by the procedures developed to relate the "civic numbers" class both to the buildings to which they belong and to the property assets (buildings and lands cadastre), that, finally, to the road (toponymy).

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Among the topics investigated and implemented in the SDI, the one concerning the urban-building fabric certainly represents the most significant one for the management and enhancement of the UNESCO World Heritage Site in relation to its exceptional value universally recognized.

The topic concerns the information coming from both the analytical investigation on the basis of a relief "standard form"[4] - through which elements of knowledge of the main characters of the buildings and their methods of use have been acquired - both from the General Recovery Plan in force that affects the area of the Sassi. In particular way, the work concerned the organization and creation of a specific thematic DB related to the elements indicated in Article 13 of the Pdr's NTA, or rather the classification of areas and buildings related to the three macro classes identified: urban rooms, the caves (hypogea), building fabric and buildings. The assumption is that, lacking an organic structuring of the databases, the realization of the SDI can contribute to pursuing also the strategies defined in the 2014-2019 Management Plan of the UNESCO site, as the deepening of knowledge is an essential aspect not only for the protection of cultural and architectural heritage, but also for its management and enhancement. Referring to the first aspect, it's believed that the SDI can represent the initial step for the establishment of the Permanent Observatory provided by the Management Plan of the Sassi District[5] itself, because the information, as structured, the information could "migrate" to a dedicated computer platform and could be managed by accredited operators, in consistency, however, with the requirements provided at the time of registration of the site in the UNESCO World Heritage List, where the systematic monitoring of the conservation status of each site is an essential element. Regarding the second aspect, instead, the SDI promotes the integrated implementation of the minimum knowledge base on which establishing protection, enhancement and management strategies of urban-building heritage. In summary, the SDI, as structured in terms of spatial relationships between the different information layers, allows to trace from the query of any data to other information contained in other archives that apparently have no connection with the data questioned (Fig. 5).

3.1 METADATIZATION INSIDE THE SDI

In line with the concepts of interoperability referred to above and aware of the role that the description of geographic dataset assumes within the processes of geolocation of information for the purposes of access to spatial data that characterize a given area, the activity of compiling the metadata was particularly important. This activity, which only simplified the most significant data, was developed through the use of a tool available on the INSPIRE platform, which allows the compilation and the saving of the information on the territorial data in line with national and EU standards. Thanks to this tool it was possible to populate metadata for some information levels present in the database; in view of the use of SDI on a dedicated IT platform, for viewing the information, just import the file saved at the end of the procedure in ".xml" format.

[4] Survey developed as part of educational activities of the School of Architecture in Matera, University of Basilicata.

[5] Management Plan of the Sassi of Matera 2014 – 2019. The Sassi and the park of the Rupestrian Churches of Matera World Heritage Site, edited by Colonna A. e Fiore D.

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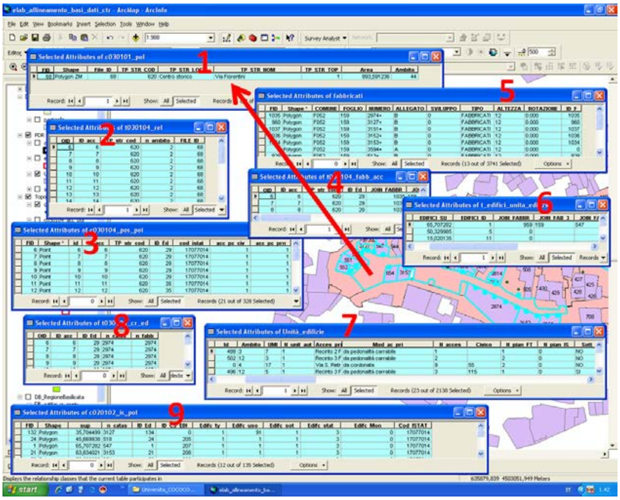

Fig. 5 Example of an SDI interrogation (the numbers highlighted in red indicate the information layers to which it's possible to trace by querying a geometry of the "street toponym" class)

3.2 IMPORTANCE OF THE SDI AND POSSIBLE FUTURE DEVELOPMENTS

The SDI, conceived as a support tool for the analyzes and elaborations concerning the recovery, valorization and urbanistic management of the historical heritage of the Sassi, describes the main characteristics of the use of the ground (open spaces), of the road infrastructures, of the settlement and toponymy.

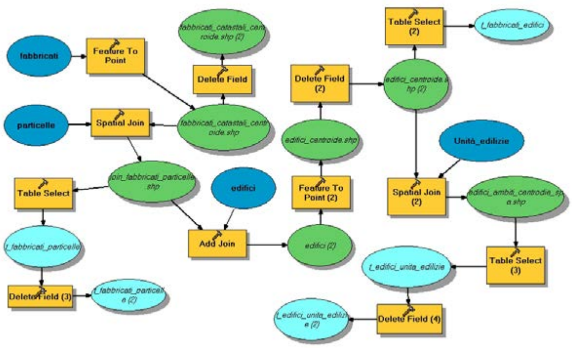

Fig. 6 Procedure for the alignment of some SDI classes (Model Builder)

Problems relating to the availability, quality, organization, accessibility of spatial information are common to many categories of information and are found at different levels of public administration. To solve at least some of these problems, it is believed that the activation of the procedures developed in the GIS environment (Figg. 6 and 7), which are based on the coherence and systemic structuring of spatial information, certainly represents a good starting point, not only for the integration and updating of the databases but also for the elaboration and representation of the elaborated indicators (Figg. 8 and 9). The

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availability of easily updatable knowledge devices, built on the basis of shared and easily replicable standards, represents, in fact, an important answer to the problems concerning data interoperability.

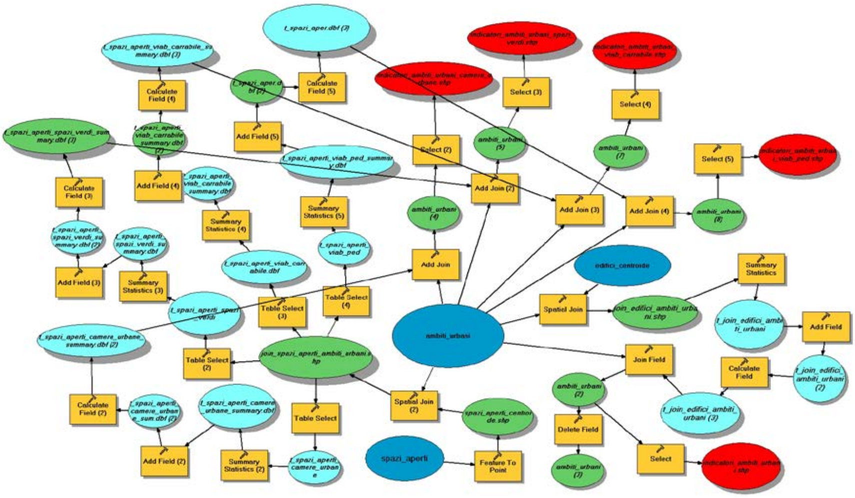

Fig. 7 Procedure for the return of some indicators related to open spaces (Model Builder)

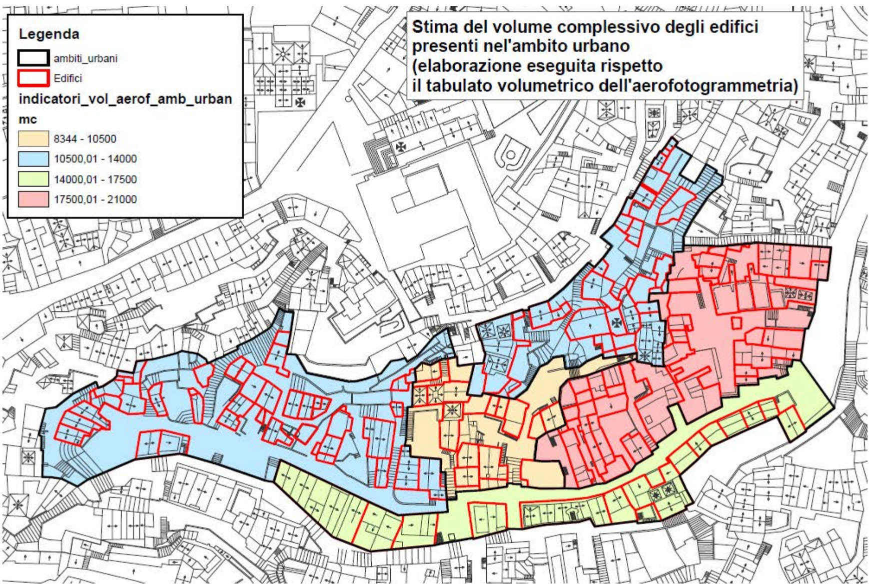

Fig. 8 Representation of some elaborate indicators

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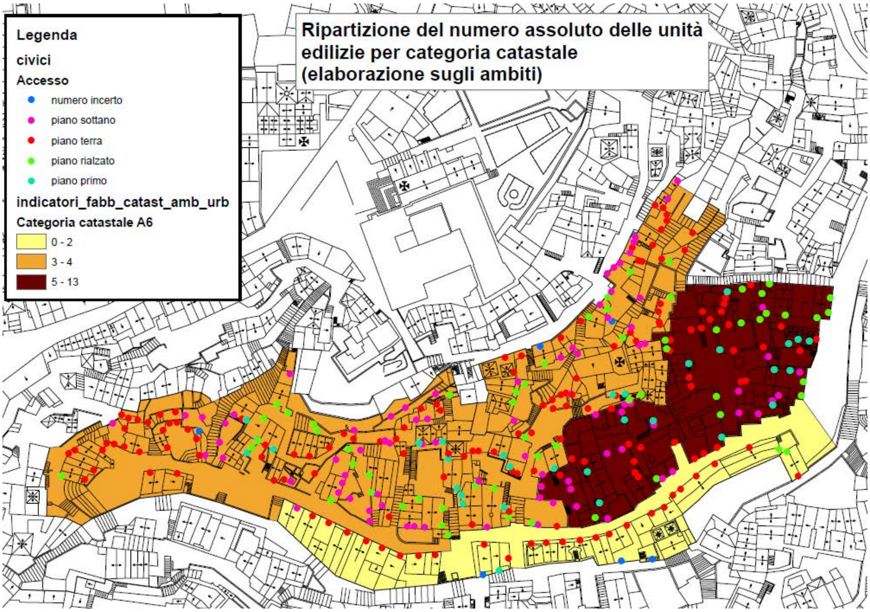

Fig. 9 Representation of some elaborate indicators

The experimentation demonstrates the feasibility of these processes; starting from the availability of geographic information present in different PA databases (Basilicata Region, Municipality of Matera), integrating this information with what is available in other institutional archives (Cadastre) or in the public domain (OpenStreetMap), it was possible to create a new database integrated (knowledge produces new knowledge), aimed at the innovative management of the UNESCO World Heritage site. The prospects of use the SDI, in fact, refer to different spheres related for example to the maintenance of vehicular and pedestrian traffic, public and/or private green areas, local taxation and taxes, planning and scheduling, toponymy, and to the building interventions. Referring to this last aspect, it is believed that the development of the SDI, although it can be improved and integrated with surveys structured in the field, can contribute more efficiently to the management of the urban-building fabric.
A further field of application of the SDI concerns both the procedures for the online processing of geographical data (quick update) and the sharing of such information. Regarding the first aspect, the SDI framework allows online data migration through a dedicated platform to be developed according to a client-server architecture in the Web environment and consistent with the specifications of the Open Geospatial Consortium (OGC) in theme of interchange/interoperability standards for WebGIS systems. For what concerns, instead, the disclosure of information could take place through the development and implementation of a simple web-based GIS system, with access modes via Internet (or INTRANET).

4 CONCLUSION

From the exposure of the experience carried out it seems to define a new approach to the themes of historical testimonial value urban fabric planning in the city of Matera, characterized by the presence of a heritage of exceptional value such as the Sassi, with reference both to aspects of methodological nature and

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to the use of innovative tools and procedures for the implementation and management of "territorial objects". The work has pursued two macro objectives: to create a useful tool to make consistent the choices made by municipal urban planning and increase the level of effectiveness in the management of urban-building heritage. The SDI is presented as an important and innovative tool in a territory (Basilicata Region) in which the use of Geographic Information Systems is not yet widely practiced, normally only for for the graphic representation of the urban planning tools; in this sense, it can represent the gateway to geographic information for the management of the city. The development of the SDI, without claiming to indicate complete and non-perfectible models, indicates a way of approaching urban planning issues which, overcoming positions of excessive rigidity and/or inconsistency of spatial information, could favor....BOTH the development of more effective synergies between the actors involved in the process of transformation of the UNESCO Site as desired in the 2014-2019 Management Plan, both to favor the modernization of the PA in line with the Community strategies for the development of the economy and digital culture (ICT).
What are the possible declinations of the SDI in a world - the WEB - that already offers sophisticated means of sharing and integrating heterogeneous information? A possible answer is inherent in the definition of SDI, to be understood as *"set of policies, technologies and institutional provisions to assist user communities in collecting, sharing and exploiting geospatial information resources"* (Masser, 2005; Nebert, 2004), which does not only concern aspects linked to technology, but also methodological aspects ~~of~~ compliance with common standards and organizational structures, essential elements to exploit the potential benefits of such IT systems for the management of the city or part of it.

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Piergiuseppe Pontrandolfi, architect, is an associate professor of Urban and Spatial Planning at DICEM of the University of Basilicata. He carries out research on urban and territorial policies and on new ~~forms~~ and tools for territorial governance. Member of research groups in European projects on issues of local development and spatial planning. President of the Cultural Association - OnLus CULTURE & TERRITORI and Coordinator of the CAST project. He has written essays and articles on national and international sector magazines, as well as being the author of some publications. Member of the Board of the Regional Section of the National Institute of Urban Planning since 1982 and of the National Executive from 1982 to 1996. From 1995 to 1999 he was Councilor for Urban Planning in the Municipality of Potenza. From 2003 to 2006 he was the coordinator of the second level University Master's degree promoted by the University of Basilicata on "New tools for government and land management". Curator for the Librìa publisher of the "Territory and Culture of Piano" series.

Antonello Azzato, territorial planner obtained the II level Master in "New tools of government and land management" at the Faculty of Engineering of the University of Basilicata. Since 2006 he has collaborated in the drafting of various municipal planning tools and the Territorial Coordination Plan of the Province of Potenza, first as a collaborator and then as a freelancer. From 2010 to 2014 he is a research fellow at the DICEM of the University of Basilicata, scientific disciplinary sector "Technical and Urban Planning". He works as a freelance for public administrations, research institutions and universities, private subjects and associations; he concentrates his competence in the field of territorial, urban and environmental planning, with particular reference to the practices of territorial governance, to urban transformation processes, to the management of the environment and the territory through management models linked to production, analysis and use of structured geographical databases with the help of local information systems. Author and co-author of articles and editorial publications.

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ON RESTORING AND REVIVING LOST RELIGIOUS BUILDINGS

MULTI CRITERIA ANALYSIS TECHNIQUES TO ADDRESS AN INCREASINGLY UNDERUSED PATRIMONY

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ABSTRACT

Historical religious heritage is vital for territorial identity. Such heritage, besides comprising most often wonderful landmarks, is a defining part of the shared identity of the population and an indispensable thread woven deep into the social fabric. In Italy, some of the buildings that once housed worship-related functions have today lost their purpose due to various causes. The conservation of these numerous historical architectures requires large amount of funds and resources. However, attempts of reviving historical sites might not succeed and consequently lead to a waste of resources. Consequently, the wise allocation of the available resources is paramount.

This work studies and proposes a MCA-based method aimed at supporting conservation designers and public decision makers in prioritizing actions and allocating resources where they can be most effective to the greatest benefit of territories and their communities.

The study area corresponds to three Italian administrative districts in the central region of Tuscany. The methodology is applied to a case-study comprised of 480 Italian architectures, including churches, oratories and chapels, which were thus further investigated. The architectures are described by a set of criteria and taken as alternatives. In order to select the ten most suitable alternatives to be used, we applied the Analytical Hierarchy Process (AHP). We chose this method because of its ability to decompose the complex decision problem involving architectural heritage into different levels of hierarchies.

KEYWORDS

Spatial Database; MCA Techniques; AH; Reuse; Religious Architectural Heritage

1 INTRODUCTION

Historical religious heritage is vital for territorial identity. Unfortunately, these days see some of the Italian worship-related buildings experiencing scarce use and maintenance problems, challenging circumstances which, in turn, can lead to abandonment (Fig. 1).

Fig. 1 Examples of underused or abandoned architectures located in the surveyed territory

The presence of religious architectural heritage is ubiquitous in Italy. Consequently, the problem of the enhancement of underused or abandoned buildings is greatly felt by anyone. However, academics think the problem is not dealt with in a sufficiently systematic way (Settis, 2011). It is common knowledge that the conservation of historical built heritage requires substantive financial resources, which are not easily available and most often dwarfed by the magnitude of the needs. Besides investigating the root causes of the problem, it is important to devise a method which can wisely and sustainably allocate the available funds in order to mitigate the failure risks being inherent to any repurposing attempt of historical sites.

Although multiple organizations such as the national or local governments have a stake in administering historical buildings, the vast majority of religious architectures devoted to worship is, in Italy, owned and managed by the Catholic Church. Given the fact that the Church's primary obligation is to provide for adequate places to hold liturgies for its communities, which sometimes may be moving away from historically relevant places following novel settlement nuclei, new, larger and brighter spaces are built to better provide for contemporary worship needs (Bartolomei, 2016), causing some of the preexisting spaces to become increasingly underused or even abandoned.

From a territorial perspective, building a strong knowledge of religious heritage, its localization and its manifold values is paramount. The Church is experiencing the same need and, through the Italian Bishops' Conference (CEI) is currently carrying out a census of all its owned built heritage. While such work is underway at the time of writing, preliminary data analysis can be found in the literature (Bartolomei et al., 2017). Thanks to their artistic and cultural status, major religious buildings are often described in books and publications. This is the case for the project named "I Luoghi della Fede" (Baldacci & Silla, 1997), which between 1995 and 2000 examined and catalogued 2527 historic religious buildings throughout Tuscany.

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This research aims at proposing a viable decision method which formulates various plausible reuse cases and checks their suitability to each of the considered buildings from a given region. The whole process then generates a hierarchy where the most promising alternatives wrt the re-purposing choices and the target territories are ranked according to both their potential value-enhancement and their impact on the local society. A general schematic for the overall process this work can be framed into is provided in Fig. 2.

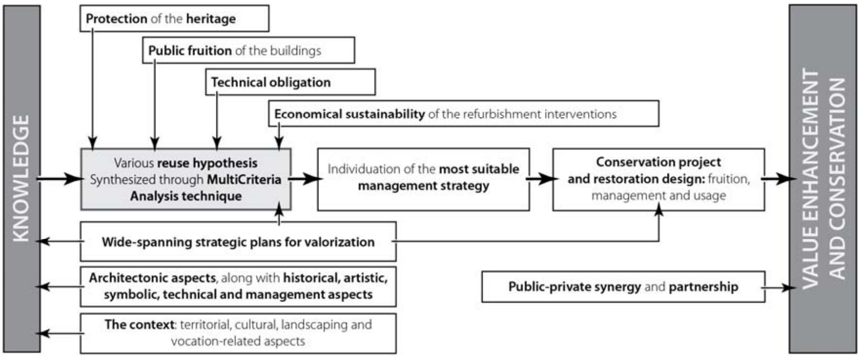

Fig. 2 The framing methodology of the whole project

Since the problem we are dealing with must drive complex decisions while considering multiple and diverse input variables, we chose to apply quantitative decision-theory tools to this particular religious-architectural-cultural field. Multi-Criteria Decision Analyses (MCDA or MCA), in fact, "involve a set of alternatives that are evaluated on the basis of conflicting and incommensurate criteria" (Malczewski, 1999).

MCA techniques represent a specific area of the Decision Analysis field (Parnell et al., 2013), which encompass every decision-making process that produces a final choice. In general, MCDA sets an articulate family of criteria, often contradicting, and assigns priorities values (called weights) to each of them. These values represent the aptness of any given criterion wrt both the driving objective of the process and the other, competing, criteria.

Various and different approaches of MCDA are presented in the literature (for a report see Figueira et al., 2005). Many of them can be applied to historical heritage (see Ferretti et al., 2014; Giove et al., 2011; Oppio et al., 2015). Following what was referred to as a "territorial approach", this study makes large use of geographical data. In fact, a large amount of the analyses of this research hinges upon a Geographical Information System (GIS), making the overall decision method a "GIS-based MCDA" (Ascough II et al., 2002; Malczewski, 1999; Malczewski & Rinner, 2015).

The entire set of surveyed architectures exceeds 2.000 religious buildings, which are situated in three Italian Provinces located in Tuscany. In the first step of the study we isolated a subset of nearly 500 architectures, which constitutes the case-study for the subsequent MCA application. In the second phase we employed the Analytic Hierarchy Process (AHP) to convey first-level overall suitability rankings and, finally, in the last phase the rankings is refined through the application of the ELECTRE III method to the ten highest scoring alternatives isolated by the AHP. So far, the research managed to complete the AHP step and set the framework of the subsequent ELECTRE III implementation. Therefore, in this contribution we will be describing the application of the AHP to the subset of alternatives extracted from the whole set of the selected architectures.

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2 MATERIALS AND METHODS

The research develops through the phases depicted in Fig. 3.

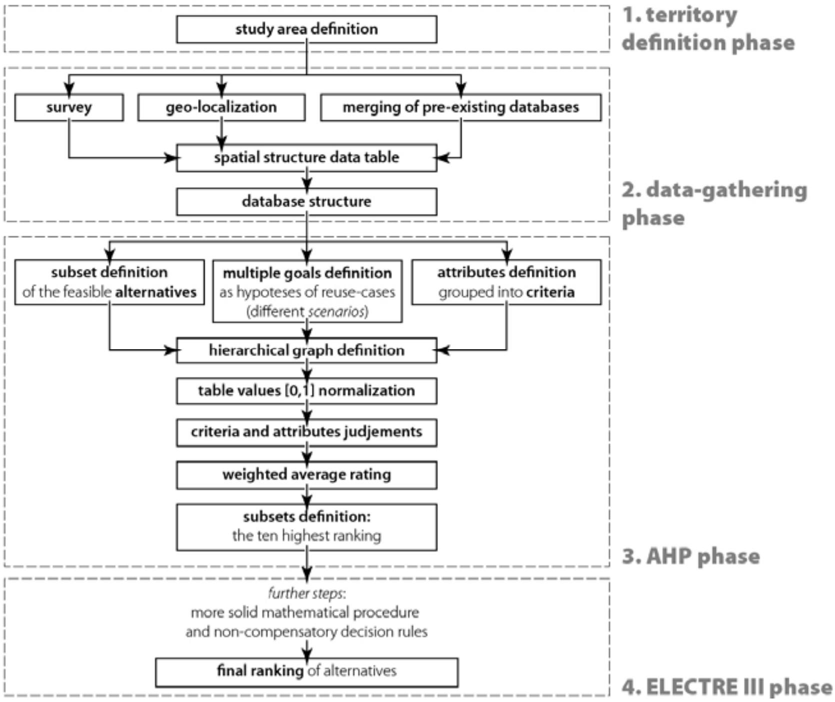

Fig. 3 The entire methodology, from the beginning of the research to the final ranking of the alternatives

2.1 STUDY AREA DEFINITION

One of the aspects that inspired the research was the recognition that nearly all studies on religious heritage begin and focus on the architectural scale, with little attention to a wider, territorial framing. Therefore, our work involves a rather extensive territorial scope. Although we want the research not to be location-specific, three Italian administrative districts are chosen as case-study territories. They are, namely, the Provinces of Pisa, Lucca and Livorno (Fig. 4). We chose these areas because of their intrinsic characteristics as well as for historic reasons: besides being inhabited since ancient times, the morphology of the three districts ranges from mountains to flatlands, from inland areas to coastal environment, offering a diverse variety of settlements to be investigated.

2.2 DATA GATHERING

Acquiring a complete and reliable dataset requires a survey, whose primary step is the rigorous geo-localization of buildings on the territory. Through the use of the opensource QuantumGIS (QGIS) software, both geographical data and attributes were handled. They were initially arranged in a geographical database, called *spatial structure data table* (Malczewski, 1999), where each row represents a particular geographical entity, in this case, a building.

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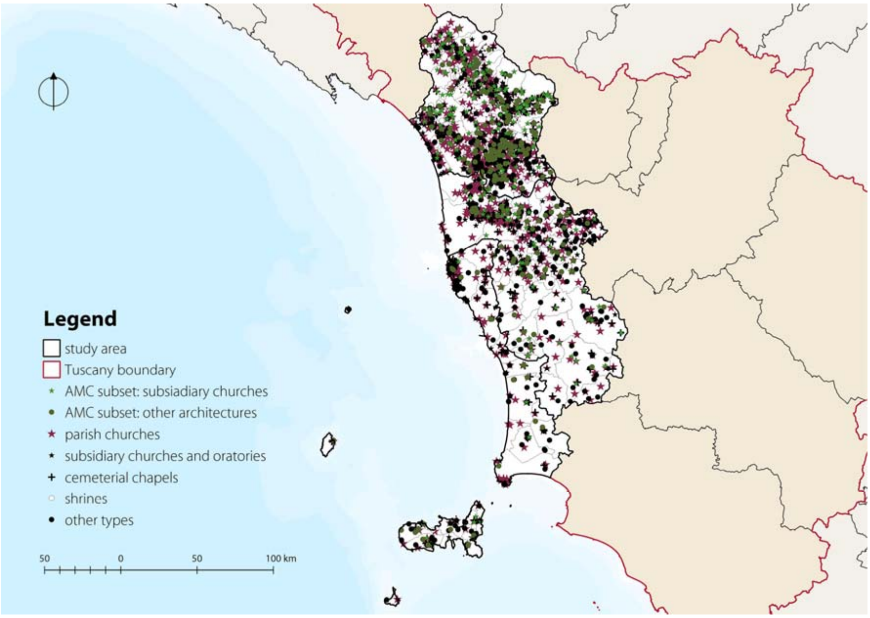

Fig. 4 The study area with geolocalised points representing religious-related buildings

Various publications were used to populate the geographical database, such as the previously mentioned lists of CEI's "The Churches of the Italian Dioceses" (CEI, 2008), the "Sacrum Luce" database, the Tuscan regional database of architectural and planning restrictions, literature from the "Places of Faith" (Baldacci & Silla, 1997) project, and the archives of the Italian National's Monuments and Fine Arts Department offices. The Tuscan Regional Technical Map (CTR) was acquired in its vector-shapefile form. It provided the essential territorial map layer into which buildings were entered but also contributed its own data by providing building locations intrinsically contained into its structure.

The CTR was subsequently enriched with several other informative layers, such as the land cover map and a road graph for the entire area. The total number of surveyed architectures is 2235, as can be seen from Fig. 5 and, visually, from Fig. 4. Gathered data was later structured into a database (Fig. 6) using PostgreSQL.

Attributes and data contained in the db comprise both quantitative and qualitative information, both a-spatial and spatial-dependant.

The most meaningful information was turned into evaluation criteria and attributes in the ensuing steps of the research for processing through MCA techniques. Among the whole dataset the case study for the subsequent MCA application was extracted (refer to the two rightmost columns of Fig. 5). It is composed of 480 architectures which:

- are not parish churches, nor cathedral churches;
- have not been previously converted;
- are scarcely used.

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TYPE	TOTAL number	TOTAL percent.	CEI DATABASE number	CEI DATABASE percent.	SUBSET number	SUBSET percent.
Cathedral churches	3	0.13%	3	0.24%	-	-
Parish churches	739	33.06%	736	58.37%	-	-
Subsidiary churches	434	19.42%	430	34.10%	225	46.78%
Subsidiary oratories	54	2.42%	54	4.28%	37	7.69%
Sanctuaries	2	0.09%	2	0.16%	-	-
Convent churches and complexes	34	1.52%	6	0.48%	4	0.83%
Private chapels and oratories	182	8.14%	2	0.16%	55	11.43%
Other public religious buildings	682	30.51%	27	2.14%	155	32.22%
Disappeared buildings	11	0.49%	-	-	-	-
Multiple category	30	1.34%	-	-	4	0.83%
Stand-alone towers and bell towers	44	1.97%	-	-	-	-
Residential functional conversions	11	0.49%	-	-	-	-
Other private functional conversions	5	0.22%	-	-	-	-
Public functional conversions	4	0.18%	1	0.08%	-	-
	2235	100%	1261	100%	480	100%

Fig. 5 Composition break-down of the whole gathered dataset

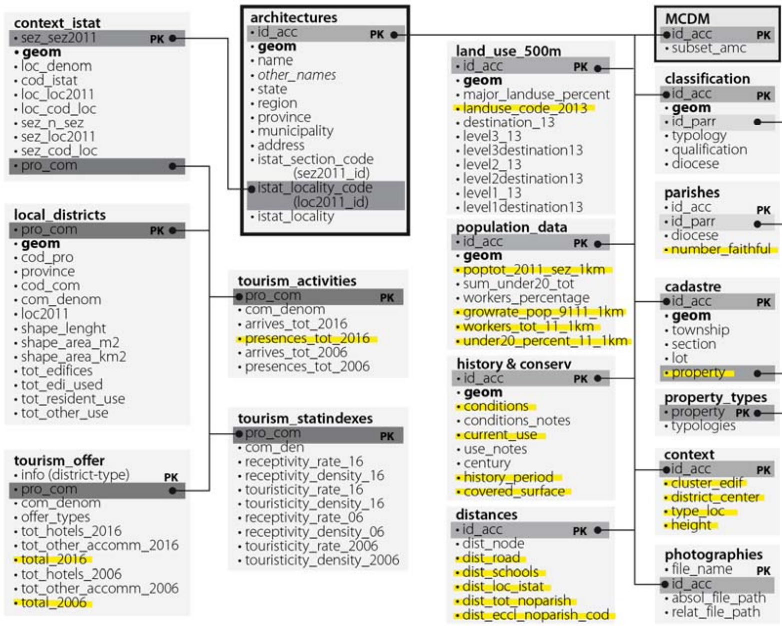

Fig. 6 The database scheme. The highlighted entries refers to the db data later turned into criteria

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2.3 THE AHP APPLICATION

The Analytic Hierarchy Process (AHP, Saaty, 1980)) is a well-established MCDA algorithm sometimes used in GIS-MCDA. Its implementation uses reciprocal paired comparisons, along with decision makers or expert judgments to prioritize both qualitative and quantitative criteria. It belongs to the set of Multi Attribute Decision Methods (MADM) and is based on the additive weighting sum. One of its peculiarities, besides its natural simplicity, resides in the weights calculation for each criterion, which is achieved using a decision matrix where each criterion is pairwise compared to each other. The AHP method is founded on the decomposition of the problem into a *hierarchy* of subcomponents which can be analyzed and judged more easily (Fig. 7 shows the research problem being subdivided into a two-layered hierarchical structure).

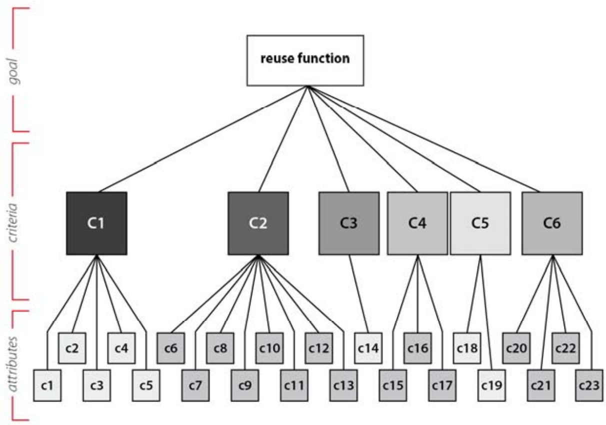

Fig. 7 The hierarchical graph. C# and c# identify the generic attributes as specified in Fig. 10

The reuse cases formulation is the starting point of the whole framework. They can be conceived and set in relation to different stakeholders available at the time. Within the scope of this research, three different categories of reuse hypotheses were conceived and further specified into 9 *scenarios* (Fig. 8). The "social" category yielded four scenarios, namely (a1) "cultural center", (a2) "parish community center", (a3) "youth center" and (a4) "scout meeting point"; the "tourism" category was specified into (b1) "info-point", (b2) "exhibition gallery and (b3) "stop of a local tourist itinerary", finally, the "economic" hypotheses include both the (c1) "business/workshop" and the (c2) "observatory" reuse cases.

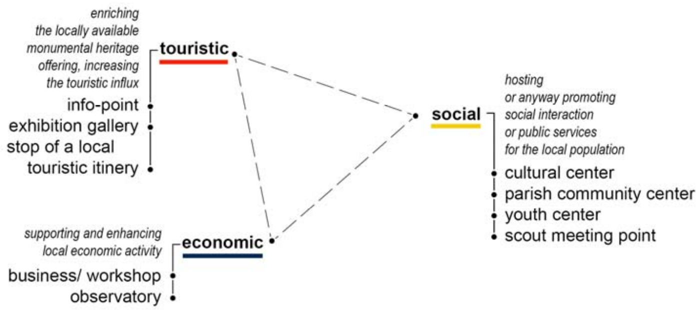

Fig. 8 Reuse-case categories and related scenarios

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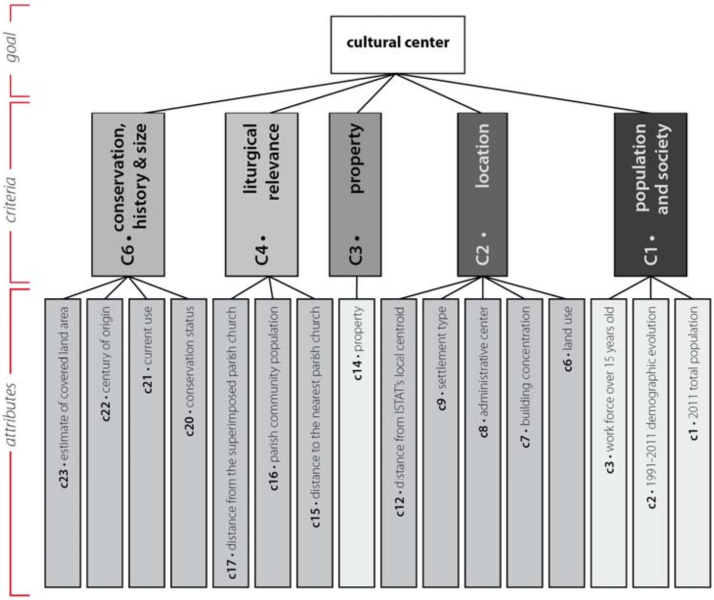

Fig. 9 Customized hierarchical scheme for the "cultural center" reuse case

	criteria weights			attribute weights		resulting weights	TOURISTIC			SOCIAL				ECONOMIC	
							Info-point	Exhibition gallery	Stop of a local touristic itinerary	**Cultural center**	Parish community center	Youth center	Scout meeting point	Business/ workshop	Observatory
C1 Population and society	0.35	**c1**	2011 total population	0.60	>	0.21	X	X	X	**X**	X	X		X	X
		c2	1991-2011 demographic evolution	0.20	>	0.07	X	X	X	**X**	X	X		X	X
		c3	work force over 15 years old	0.20	>	0.07	X	X	X	**X**	X	X		X	X
		c4	2011 population % under 20 years old	---	>	---						X	X		
		c5	distance from secondary schools	---	>	---						X	X		
C2 Location	0.35	**c6**	land use	0.06	>	0.02	X	X	X	**X**	X	X	X	X	X
		c7	building concentration	0.31	>	0.11	X	X		**X**	X	X	X	X	X
		c8	administrative center	0.26	>	0.09	X	X		**X**	X	X	X	X	X
		c9	settlement type	0.28	>	0.10	X	X	X	**X**	X	X	X	X	X
		c10	distance to the nearest road	---	>	---	X	X	X					X	
		c11	distance from hiking paths	---	>	---			X				X		
		c12	distance from ISTAT's local centroid	0.09	>	0.03	X	X		**X**		X	X	X	X
		c13	altitude/height	---	>	---			X				X		X
C3 Property	0.11	**c14**	property	1.00	>	0.11	X	X	X	**X**	X	X	X	X	X
C4 Liturgical relevance	0.12	**c15**	distance to the nearest parish church	0.41	>	0.05	X	X	X	**X**	X	X	X	X	X
		c16	parish community population	0.26	>	0.03	X	X	X	**X**	X	X	X	X	X
		c17	distance from the superimposed parish church	0.33	>	0.04	X	X	X	**X**	X	X	X	X	X
C5 Tourism	0.00	**c18**	2016 touristic daily presences	---	>	---	X	X	X					X	
		c19	2006-2016 accommodation growth rate	---	>	---	X	X	X					X	
C6 History, conservation and size	0.08	**c20**	conservation status	0.13	>	0.01	X	X	X	**X**	X	X	X	X	X
		c21	current usage	0.13	>	0.01	X	X	X	**X**	X	X	X	X	X
		c22	century of origin	0.38	>	0.03	X	X	X	**X**	X	X	X	X	X
		c23	estimate of covered land area	0.38	>	0.03	X	X	X	**X**	X	X	X	X	X

Fig. 10 6 evaluation criteria (C#) and 23 attributes (c#) are the foundation of this AHP application. The 9 columns show which of the attributes are relevant to the 9 reuse cases (right). Weights refer to the "cultural center" reuse scenario(left)

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According to Fig. 7 and Fig. 10, six criteria define the upper level of AHP hierarchical graph, describing the major investigating fields which are considered for the alternatives, namely (i) "population and society", (ii) "location", (iii) "property", (iv) "liturgical relevance", (v) "tourism", (vi) "history, conservation and size" of the architectures. They are further specified via 23 sub-criteria, also referred to as *attributes*. When defining the criteria and the attributes, both spatial related features and intrinsic/a-spatial characteristics were considered. Not all of the 23 criteria were considered altogether during each AHP application, thus criteria subsets were detailed, according to the right part of Fig. 10. This led to the definition of 9 customized hierarchical schemes (Fig. 9).

The score matrix was then defined by extracting meaningful information from the database. Some of the criteria scores directly came from database inputs, either from the survey (criteria referred to as c14, c20, c21, c22 in Fig. 10), from statistical data (c18, c19) or from ecclesiastical annals data (c16). Other criteria values required more steps to be extracted. Numerical scores could be extracted by sampling vector data (c7 is extracted from a previously interpolated criteria map, c8 and c9 are sampled from geo-localized vector data of the ISTAT census, c11 refers to different distance ranges obtained via linear buffering from Open Street Map elements, c13 is sampled from the Tuscan Digital Elevation Model raster file and c23 is extracted from the regional map vector polygonal data) or, more complexly, via SQL queries carried out in postgreSQL (c1, c2, c3, c4, c6), also in conjunction with the Dijkstra algorithm (Khan, 2016, for the c5, c10, c12, c15, c17 criteria) used to compute shortest-path distances.

As an example, the c1 criterion score values were extracted from 2011 ISTAT population tabular census data (ISTAT, 2017) linked to their pertinent reference areas. These census areas, along with the point dataset of the alternatives, were imported into postgreSQL and processed using the SQL query shown in Fig. 11.

```
DROP TABLE IF EXISTS pop.sez_11_pop4;
CREATE TABLE pop.sez_11_pop4 AS SELECT * FROM
  pop.sez_11_pop_all;
ALTER TABLE pop.sez_11_pop4 ALTER COLUMN geom
  TYPE geometry(Polygon,3003) USING ST_Geome-
  tryN(geom, 1);
ALTER TABLE pop.sez_11_pop4 ADD CONSTRAINT
  id_11_pop4_pk PRIMARY KEY (id);
DROP TABLE IF EXISTS pop.ep_alt_pop_11_4;
CREATE TABLE pop.ep_alt_pop_11_4 AS SE-
  LECT aa.id, a.sez2011, a."11_P1" AS pop1,
  a."11_P14" AS pop14, a."11_P15" AS pop15,
  a."11_P16" AS pop16, a."11_P17" AS pop17,
  a."11_P60" AS pop60, a.area_orig, st_
  area(st_intersection(a.geom, aa.geom))
  AS sup, st_intersection(a.geom, aa.geom)
  AS geom FROM pop.sez_11_pop4 a, (SELECT
  b.id_acc AS id, st_buffer(b.geom, 1000) AS
  geom FROM pop.ed_tot b) aa WHERE st_inter-
  sects(a.geom, aa.geom) ORDER BY aa.id;
ALTER TABLE pop.ep_alt_pop_11_4 ADD COLUMN
  pop_id_11_4 serial;
ALTER TABLE pop.ep_alt_pop_11_4 ADD CON-
  STRAINT pop_11_id_4_pk PRIMARY KEY (pop_
  id_11_4);
```

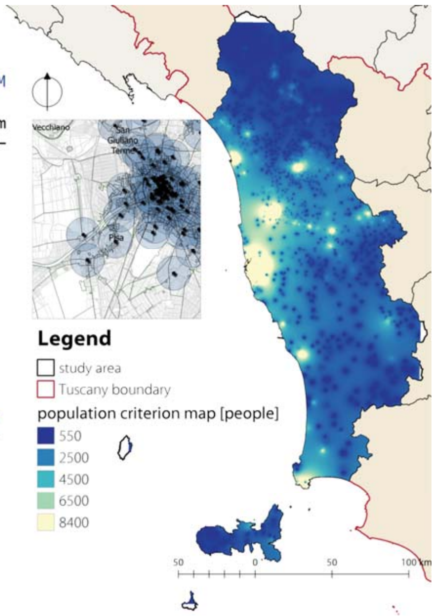

Fig. 11 SQL query example employed for the definition of the area buffers (left); population distribution of the entire study area (right); area buffers around the city center of Pisa (middle)

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Doing so, each point is evenly assigned a proportional amount of population, making it possible to compare differently located alternatives. Depending on the different reuse strategies, and within the same goal hypothesis, not all of the criteria have the same importance. Therefore, relative weights for the criteria have to be derived. Within the scope of this work, the preferences are considered *spatially homogeneous*, thus every criterion was assigned only a single-valued weight. The judgment elicitation was carried out constructing multiple preference matrices.

Like most of the other MCDA methods, AHP requires comparing and aggregating the criteria values contained into the score matrix. This can be obtained with standardization techniques, by which the value scaling into a [0.1,1] interval is carried out through customized *value functions*. Such functions transform an alternative's dimensioned raw score to a dimensionless score, between 0.1 and 1. Fig. 12 shows different application of value functions for 5 out of 23 attributes related to the "cultural center" reuse case. As a shared rule throughout the research, a minimum value of zero is avoided and replaced with 0.1, as the least desirable condition. A score of "1" indicates instead the optimum state. While c1, c2, c3 and c7 represent quantitative values, the c6 attribute, which summarizes land cover data, translates qualitative information into an ordered scale of values by pairwise comparison. Both data types are thus scaled into the universal [0.1,1] interval.

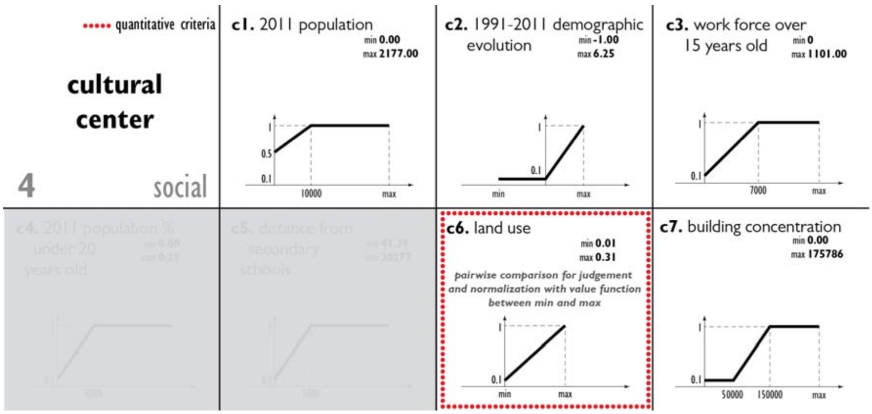

Fig. 12 Value functions used for the standardization process into the [0.1,1] interval

The overall ranking score, which express the suitability for each alternative wrt the driving decision goal, is given by:

$$A_k = \sum_{i=1}^{N} w_i a_{ki} \text{ for } k = 1, \dots, M$$

where A_k is the resulting score of the *k*-th alternative, w_i is the *i*-th weight value, *N* is the total number of criteria, a_{ki} is the score value of the *i*-th criterion wrt the *k*-th alternative and *M* is the total number of the feasible alternatives. For each scenario the equation produces a ranked list, from which the ten highest-scoring alternatives are extracted. They constitute the subset for a more mathematically solid ranking formulation. Before that, a sensitivity analysis was performed to check if and how the selection among possible alternatives would change in the case of different criteria weights.

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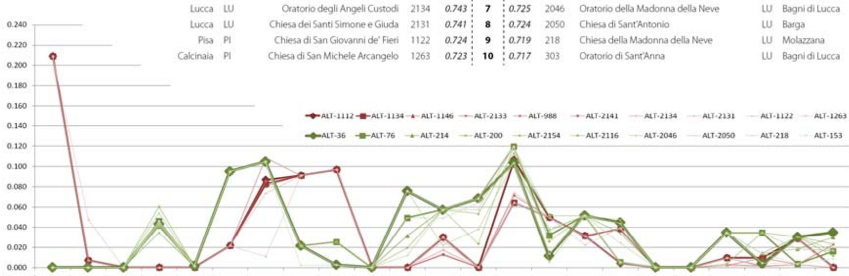
3 RESULTS AND DISCUSSION

The method is applied to each of the reuse hypotheses, resulting in 9 ranked lists. Fig. 13 shows the comparison between the AHP rankings and the score graphs for two example cases, whose results are shown in Fig. 14. Architectures connected to the "cultural center" reuse case clearly appear to be located in major city centers, such as Pisa, Lucca and Pontedera, whereas the architectures housing "scout meeting points" are quite spread over the Garfagnana territory. Unsurprisingly, such macroscopic differences are consistent with the core characteristics of the considered reuse cases.

AHP is employed in this research for choosing subsets of alternatives to be further investigated via non-compensatory decision tools, producing a more solid ranking of the architectures. However, AHP lists can be employed as final rankings, being able to give preliminary guiding orientations to stakeholders and decision makers, especially when considering all of the lists.

Cultural center						Scout meeting point				
city	province	name	ID	score	rank	score	ID	name	province	city
Pisa	PI	Chiesa di Santo Stefano dei Cavalieri	1112	*0.782*	**1**	*0.782*	36	Chiesa di Sant'Antonio	LU	Minucciano
Pisa	PI	Chiesa di Santa Maria dei Galletti	1134	*0.770*	**2**	*0.764*	76	Oratorio di San Michele	LU	Vagli Sotto
Pisa	PI	Chiesa di San Paolo all'Orto	1146	*0.761*	**3**	*0.754*	214	Chiesa di San Paolino Vescovo e Martire	LU	Barga
Lucca	LU	Chiesa di San Benedetto in Gottella	2133	*0.759*	**4**	*0.743*	200	Chiesa di Santa Maria	LU	Pieve Fosciana
Lucca	LU	Chiesa di Santa Giulia	988	*0.746*	**5**	*0.738*	2154	Cappella interna alla Rocca della Verruca	PI	Vicopisano
Pisa	PI	Chiesa di San Gregorio Magno	2141	*0.746*	**6**	*0.731*	2116	Chiesa di San Lorenzo	LI	Marciana
Lucca	LU	Oratorio degli Angeli Custodi	2134	*0.743*	**7**	*0.725*	2046	Oratorio della Madonna della Neve	LU	Bagni di Lucca
Lucca	LU	Chiesa dei Santi Simone e Giuda	2131	*0.741*	**8**	*0.724*	2050	Chiesa di Sant'Antonio	LU	Barga
Pisa	PI	Chiesa di San Giovanni de' Fieri	1122	*0.724*	**9**	*0.719*	218	Chiesa della Madonna della Neve	LU	Molazzana
Calcinaia	PI	Chiesa di San Michele Arcangelo	1263	*0.723*	**10**	*0.717*	303	Oratorio di Sant'Anna	LU	Bagni di Lucca



ALT	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23
ALT-1112	0.209	0.007	0.000	-	-	0.022	0.087	0.091	0.097	-	-	0.030	-	0.107	0.050	0.032	0.004	-	-	0.010	0.010	0.029	0.000
ALT-1134	0.209	0.007	0.000	-	-	0.022	0.083	0.091	0.097	-	-	0.030	-	0.064	0.050	0.032	0.038	-	-	0.010	0.010	0.029	0.000
ALT-1146	0.209	0.007	0.000	-	-	0.022	0.081	0.091	0.097	-	-	0.030	-	0.064	0.050	0.032	0.039	-	-	0.010	0.002	0.029	0.000
ALT-2133	0.209	0.007	0.000	-	-	0.022	0.109	0.091	0.097	-	-	0.012	-	0.064	0.050	0.031	0.039	-	-	0.002	0.002	0.003	0.023
ALT-988	0.209	0.007	0.000	-	-	0.022	0.109	0.091	0.097	-	-	0.013	-	0.064	0.050	0.031	0.039	-	-	0.002	0.010	0.003	0.000
ALT-2141	0.209	0.007	0.000	-	-	0.022	0.086	0.091	0.097	-	-	0.030	-	0.071	0.050	0.032	0.039	-	-	0.010	0.001	0.003	0.000
ALT-2134	0.209	0.007	0.000	-	-	0.022	0.109	0.091	0.097	-	-	0.018	-	0.064	0.050	0.030	0.039	-	-	0.004	0.002	0.003	0.000
ALT-2131	0.209	0.007	0.000	-	-	0.022	0.109	0.091	0.097	-	-	0.018	-	0.064	0.050	0.030	0.039	-	-	0.002	0.002	0.003	0.000
ALT-1122	0.209	0.007	0.000	-	-	0.022	0.074	0.091	0.097	-	-	0.026	-	0.074	0.050	0.032	0.004	-	-	0.010	0.001	0.029	0.000
ALT-1263	0.209	0.048	0.000	-	-	0.022	0.011	0.091	0.097	-	-	0.030	-	0.064	0.050	0.022	0.039	-	-	0.010	0.002	0.029	0.000

Fig. 13 Score matrix (bottom), score graph comparison (middle) and two AHP rankings (top) for the "cultural center" and the "scout meeting point" example cases

4 CONCLUSIONS

By making use of well-established MCDA tools, this work has proposed an algorithmic framework which is able to provide valuable guidance on reuse choices and investments, in order to assist decisions and maximize effectiveness of the available resources. In addition, based on quantitative input information describing both the buildings and their relations to the surroundings, this contribution presents, through the descriptions of 480 buildings, a real-world application example.

Once the rankings are finalized, it is important to verify the sustainability of the identified reuse hypotheses and value-enhancement strategies against the needs of the territory, both on a wide, geographical and on a narrower, local scale. Moreover, we are aware that, as much important the ranking lists may be, they are still

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meant to complement, not replace, human decisions. Finally, improving the ability of automatic algorithms to capture the full Return On Investments (ROI) value of restored buildings, both economic and social, should be the subject of future research.

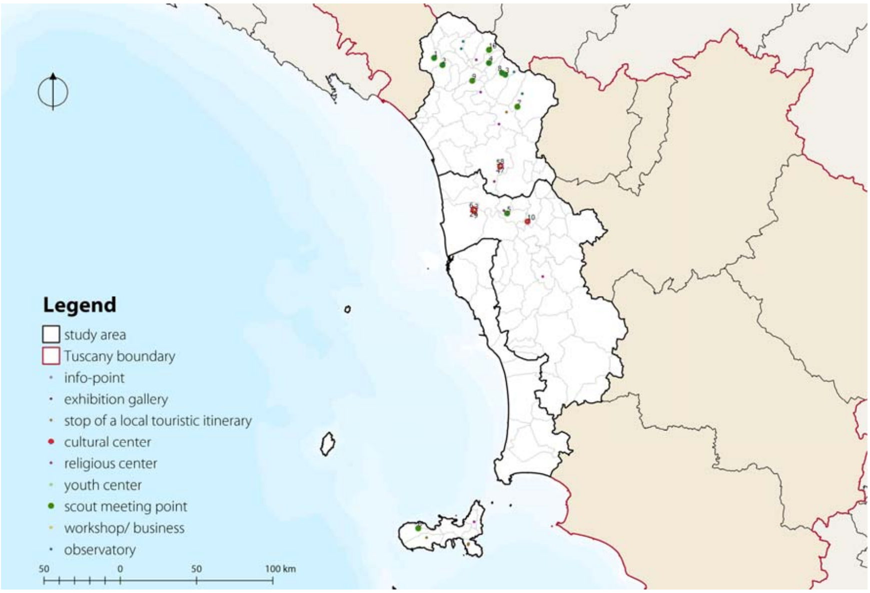

Fig. 14 Ranking results for two examples: "cultural center" and "scout meeting point"

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GAP REDUCE

A RESEARCH & DEVELOPMENT PROJECT AIMING AT DEVELOPING A TOOL FOR PROMOTING QUALITY OF URBAN LIFE OF PEOPLE WITH AUTISM SPECTRUM DISORDER

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ABSTRACT

The paper focuses on the rarely discussed topic of the relation between the city and people with ASD (Autism Spectrum Disorder), with the specific aim of promoting their individual "urban capabilities" (Talu 2013, 2014; Blečić, Cecchini, Talu, in press) by increasing the autonomy and safety of walking across the city at the neighborhood scale. Current researches and applications aimed at exploring the role of spatial configuration as a means for improving the autonomy of people with ASD, exclusively focus on the definition of criteria for the design of closed, separated, private spaces, devoted only to people (mainly children) with ASD (i.e. assisted living residences, day care centers and schools, healing gardens) (i.e. Beaver 2003, 2006; Brand 2010; Gaudion e McGinley 2012; Herbert 2003; Linehan 2008; Mostafa 2008; Sachs e Vincenta 2011; Wilson 2006). The growing incidence of ASD (Centers for Disease Control and Prevention-CDC's prospects estimates 1 in 68 children identified with ASD in United States) and the need to guarantee during adulthood the actual opportunity to exercise the achieved level of autonomy and independence, are the main reasons that lead us to think that it's necessary to 'broaden' the research perspective by investigating also the specific contribution of urban mobility policies and urban design to the enhancement of the quality of life of people with ASD. Starting from these considerations, the paper describes the first results of an ongoing research project - called GAP REDUCE - aimed at designing an integrated system of urban mobility policies, urban projects, and tools for promoting the real opportunity for people with ASD of "using" their everyday city.

KEYWORDS
People with Autism; Quality of Urban Life; Urban Capabilities

1 INTRODUCTION

In this paper we report the first results of a two years research and an ongoing project called GAP REDUCE, aimed at meeting the spatial needs of people with *Autism Spectrum Disorder* (ASD) in the urban environment and at promoting their individual *urban capabilities* (Blečić et al., 2018; Talu, 2013, 2014) through the development of an integrated system of urban mobility policies, projects and tools for enhancing their real opportunity of using the everyday city. More precisely, the purpose of the GAP REDUCE project will be the design of an App that supports people with autism to plan, with ease and *in advance,* an urban itinerary towards possible destinations chosen among urban spaces and services used in daily life. The tool is conceived to enable people with autism to autonomously reach the desired urban opportunities, thus enhancing their capabilities. The interest for autism originates from recent advancement in scientific and clinical knowledge. Autism spectrum disorder is the most widespread developmental disability (Giofrè, 2010) with an incidence in the USA of 1 out of 58 (CDC, 2018). Beyond this, three main reasons boost this research and even more encouraged the development of innovative tools able to increase independence during adulthood. First, the transition from childhood to adulthood entails the loss of a series of different public health support services; secondly, the high variety of sensorial stimuli and the unpredictability of contemporary cities make the urban environment hardly accessible for all those inhabitants who, like people with autism, live with a form of sensory disability; finally, the presence of very few researches that investigate the interaction between people with autism and the urban environment (Beane-Ellis, 2017; Davidson & Henderson, 2017; Decker, 2014). GAP REDUCE takes part to the broader research-action process started in 2016 and focuses on the operationalisation of a set of tools that assist people with autism to walk autonomously in urban space and to accomplish actions recurring in daily life. For this purpose, the project assumes the outcomes of the preliminar study, namely the recognition of three "atypical urban functionings" characteristic of the interaction of people with autism with the built environment (for the definition of *atypical functioning* see Terzi, 2011):

i) the sensory perception problems;
ii) the need to communicate using the support of images/pictures/symbols;
iii) the need to follow a routine and to use schedules and visual instructions to acknowledge and praise the successful completion of a given accomplishment.

The definition of these atypical urban functionings is the result of an in-deep study (on the spatial behaviours of people with ASD) based on the available scientific literature and, above all, on the direct support of several experts of ASD whose contribution was fundamental for the construction of the knowledge framework (researchers and medical staff of the Department of Neuropsychiatry of the University Hospital of Sassari, special needs teachers of different primary schools, the association of the parents of people with autism Angsa Sassari onlus).

According to these assumptions, the two main goals of GAP REDUCE are:

- the definition of a urban vocabulary made of images[1], that identifies and describes recurrent critical situations in the urban environment (circumstances or places which can be dangerous or cause risks to

[1] The images will be developed on the basis of the international codified system of Augmentative and Alternative Communication

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the security of people with autism, caregivers and other road users or that may cause a state of confusion/ambiguity/misinterpretation on the part of people with autism);

- the implementation of a software demonstrator that allows to i) automatically plan an urban itinerary with origin and destination chosen by the user which results advisable for people with autism and ii) to visualise, for each O-D route alternative, a sequences of images that illustrates the micro-actions to be executed in order to reach the selected destination and to deal with the critical urban situations that can be encountered along the path.

The GAP REDUCE App is conceived to aid and address mainly high-functioning adult people, but it can also be at support of any caregiver of people with a lower level of autonomy.

2 ANALYSIS OF RELEVANT ELEMENTS IN URBAN ENVIRONMENTS

As introduced in the previous paragraph, the possibility of people with ASD to perform short paths across the city by foot, in autonomous and safe conditions, is extremely compromised due to recurrent critical situations in the urban context.

In this regard, the collaboration with experts of autism led to the definition of an initial framework of built environment circumstances and qualities to be considered in the evaluation of the best route planning solutions. The presence of road intersections and physical obstacles along the path, the barrier effect of vehicular traffic, as well as the existence of trees, green areas, undisturbed spaces (Beale-Ellis, 2017), spatial elements that act as reference points, etc. all influence the behavior of pedestrians in urban space and of people with ASD in particular; hence these factors have to be included in the device setting right from the outset. Tab. 1 gives an outline of critical circumstances and favourable spatial elements and features that influence the behaviour of people with ASD when walking through the city and, as such, to be included in the route selection model. Each item is described by the spatial variables to be considered for an objective identification of the specific situation that may take place and by a description of the effects it may have on people with autism (i.e. problems generated or support offered). More precisely, the critical situations refer to actions that the individual is called to perform during the journey and which may involve difficulties, disturbance, uncertainty and disorientation, thus demanding specific instructions with regard to the behaviour to take on. The favourable urban features and spaces play the role of reference and reassuring elements along the path itself to take advantage of (i.e. bus stops, newsstands, parks and equipped green areas, neighborhood amenities such as school, church, library...).

Tab. 1 helps to draw up a list of feasible waypoints to assign to the itineraries to be recommended. The adopted waypoints correspond to objectively identifiable elements of the built environment considered essential to support people with ASD to recognise and face problems (i.e. traffic lights, zebra crossings) as well as to perceive the route more recognizable and friendly. These elements meet primarily the requirements of convenience (based on O-D distance), safety and certainty.

Furthermore, a second collection of built environment characteristics (Tab. 2) is used to set up the model so that it can evaluate the quality of the routes and of pedestrian accessibility. This second step allows to classify the route alternatives previously selected based on their suitability to be walked independently by people with autism. The spatial requirements to be satisfied at this stage concern quality of access, comfort of paths, legibility and calmness.

The same requirements orient the formulation of the sequence of instructions and of the related images.

In order to test the practicability of the theoretical assumptions we have selected the neighborhood of Sacro Cuore in the city of Sassari as a pilot study area.

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The location of the neighborhood within the urban fabric, its spatial structure and specific demographic and socioeconomic characteristics – high concentration of children and elderly people compared to the average of Sassari and predominance of medium-low income households – that as vulnerable groups share many spatial needs with people with autism – make the neighborhood of Sacro Cuore an eligible setting to experiment novel solutions, with the aim to replicate them in other neighborhoods and scale at city level.

CRITICAL/FAVOURABLE SITUATIONS	SITUATION TYPOLOGY AND SPATIAL VARIABLES	PROBLEMS/ADVANTAGES DESCRIPTION
Pedestrian path	– sidewalk presence/absence – sidewalk width pedestrian/vehicles separation (green strip, on street parking, bike lane) – physical obstacles along the sidewalk (light poles, bins, trees, bike racks…)	Limitation in space extent, obstruction, direct exposition/protection to traffic
Pedestrian crosswalk	– presence/absence of traffic light at junctions – midblock crosswalk – single/multi-lane carriageway	Risk for traffic safety and direction problems
High Sensorial stimuli environments	– congested roads – crowded spaces (on street stalls, groups of people assembled)	Disturbance and difficulty in managing many different stimuli
Bus stop	– presence of bus shelter – only vertical signage	Difficulty in the use of transit, convey certainty
Urban functions and facilities	presence of schools, commercial activities, public facilities	Convey specific uses and support to direction problems
Parks, green areas	presence/absence	Restorative and calming areas
Unforeseen/unpredicted	– construction sites – events	Direction problems

Tab. 1 Urban circumstances and related spatial elements influencing people with ASD use of the city

3 TECHNOLOGICAL FRAMEWORK

From the technological point of view, GAP REDUCE aims to develop a Proof of Concept (PoC) of an urban navigator, able to translate a standard path on a map into a sequence of visual instructions using the urban vocabulary. The PoC will be able to identify on a map the scenarios that are considered safe for people with ASD, calculate the fastest and most advisable route and show instructions to walk along the path.

GAP REDUCE will be developed using public cloud computing platforms, which will permit to avoid the CAPEX (CAPital EXpenditures) connected with the purchase and management of the hardware infrastructure, and to limit the OPEX (OPerative EXpenditure), exploiting the pay-per-use model typical of cloud services.

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QUALITY REQUIREMENTS	ATTRIBUTES	DESCRIPTION
Physical accessibility	– sidewalk continuity/interruption – presence of slide/ramps	Architectural barriers
Comfort	– footpath maintenance (bumpy, sliding pavement) – presence of trees and shade – opaque/reflecting surfaces; dazzling lights – seats, water, ...	Risk of falling, motor-control and visual skills difficulties, path friendliness/pleasantness
Low sensorial stimuli environments	– small and reserved areas – transparency (filters between functional areas) – enclosure – shade elements/furnitures	Visual relation with surroundings Rebalance sensory overload Sense of inclusion
Legibility	– signs – reference elements	Orientation and recognisability

Tab. 2 Spatial qualitative attributes for the classification of route alternatives

Fig. 1 The pilot study area: the neighborhood of Sacro Cuore, Sassari (Italy)

The PoC will be developed considering the reusability and the evolutionary support of the developed software, which will be guaranteed using standard communication protocols such as REST APIs.

3.1 STATE OF THE ART OF SIMILAR PROJECTS

For people with ASD, technology can be a great support in daily life. Recently, several types of software have been developed to help people with disabilities to improve their self-reliance in urban mobility. Google

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Maps has recently activated a new feature (Akasaka, 2018) addressed to wheelchair users and based on information about accessibility. This function allows to calculate routes taking into account the needs of people on wheelchairs, e.g. presence of ramps or width of sidewalks. So far, this feature is available only in some big cities as London, New York, Mexico City, etc., but it will be available worldwide compatibly with the availability of the necessary information. Similar applications are designed or developed also for partially sighted and blind people. For example, the app "L'occhio della città intelligente" (Ariani, 2018) aims at helping these patients to use navigation systems on the smartphone, implementing a list of favorite places and a feature that can geolocate the user and find points of interest around their position.

Another project concerns the design of a software able to calculate specific routes for blind people (Cohen, 2016). This work aims at building a network graph with the OpenStreetMap data, designed and tailored specifically for wayfinding for blind pedestrians. The building process consists of processing OSM data to represent routes as nodes and edges of a graph, giving a weight to the edges based on the specific needs of blind people and the respective constraints. This process is automatic and focused on some criteria such as the kind of street, the presence of traffic lights, stairs or tactile paving.

For example, in this way streets with tactile paving will be more likely chosen compared to streets with stairs or steps. The result of this process will be a weighted graph in which it will be possible to use a routing algorithm to find the best path for people with this disability. This research work meets some common points with the development strategy of GAP REDUCE, especially for what concerns the categorization of the road elements that can be useful or that should be avoided while calculating the routes. However, GAP REDUCE will concentrate on people with ASD needs and will use Google Maps APIs to show markers and routes. In addition, GAP REDUCE will have its own database for storing Points of Interest (PoIs).

Similarly to GAP REDUCE, other apps are addressed to people with cognitive disabilities, such as PIUMA (Cena, 2017), that aims at providing a spatial support in the form of a personalized crowdsourced map-agenda, which will contain habitual paths and PoIs relevant for the patient. In this case, PoIs will be added by people with ASD, caregivers and also people that just wish to contribute. People affected by ASD tend to have a reduced range of activities and interests, often preferring mechanical, deterministic situations and recurrent interpretations, having the need to find reassurance by sticking to rigid repetitive routines, which turns into problems in managing unexpected events. This highlights the need to plan and store habitual routes and have support in case of deviations from the planned itinerary. The major improvement introduced by PIUMA is the possibility to access a fully personalized map based on the needs of people with ASD, e.g. suggesting alternative routes based on less crowded streets. GAP REDUCE integrates some of the previous aspects providing functionalities that help people with ASD to avoid problems or cope with them in their daily routine, providing automatic route generation mechanisms associated with the possibility to modify and save the paths. In addition, GAP REDUCE will associate routing commands to proper images that represent the actions to be carried out.

3.2 FUNCTIONAL DESCRIPTION

The need to find the most suitable route for people affected by ASD is one of the most interesting technical challenges of this project. The idea is to find a path that connects the origin and the destination through a series of safe and reliable points. In this way, ASD patients will follow routes that, for example, will pass through a green area or cross the road only at intersections provided with traffic lights.

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Going into deeper detail on how the application works, it is divided into two main steps: the first one is the planning of the path to be followed and is intended to be performed by a caregiver, the second one is the routing of the patient by means of special symbols commonly adopted to help people affected by ASD.
The planning phase is done by a specific screen in which the caregiver can select two points (i.e. origin and destination) and choose among the possible solutions calculated by the routing algorithm.
The same phase allows also to modify the route in order to avoid or prefer certain points or streets, and finally to simulate the chosen path for a further verification by the caregiver and for a first *learning* by the patient. The key for being able to build the routing algorithm is a database that will store these Points of Interest (PoIs) as geographical points, each one with a functional description that characterizes it. The algorithm will find a set of possible routes, will make an assessment of each of them and finally will get the best route considering some sorting parameters in order, for instance, to prefer a safer path to the shortest one. The chosen will be shown on the map and the user will be able to modify or validate it.
After the planning phase performed by the routing engine and confirmed by the caregiver, the actual routing can start: this consists of a screen where all the routing indications are shown using a set of special symbols and, as an option, they can be complemented by realistic pictures of urban features. This way of routing aims to be as much as possible similar to the physical instruments that people with ASD use nowadays for following routines in everyday life. During the routing phase, the patient could potentially be in a situation that has not been foreseen while planning the route, such as a closed road, a car accident, a traffic light that is not working or simply he/she can lose the sense of direction. For all these situations, the application provides an emergency button that automatically dials the number of a caregiver that can give some advice by phone or even intervene directly in case of major issues. This function, besides being a secure way to take care of any kind of deviations from the intended path to be followed, is also a safe way to manage any possible issues coming from the outside (e.g. rain, noise, etc.).

4 CONCLUSIONS AND FUTURE WORK

We presented an ongoing project, GAP REDUCE, concerning the development of a ICT tool aimed at supporting the pedestrian mobility of people with autism in urban environments, in order to give them the opportunity to reach autonomously and in safe condition a set of destinations useful for their daily life.
More precisely, given the atypical urban functionings of these category of citizens, the main objective of GAP REDUCE is to develop a solution that will allow people with ASD to know in advance the path to follow and to visualize in an ad-hoc "visual language" the sequence of micro-tasks to be carried out in order to perform a specific action, such as crossing the road or using public transportation.
The research proposes an operational way to deal with some recurring situations and features of the urban environment that limit or prevent people with ASD from practicing urban space independently. At the same time, the actions implemented for promoting the need for autonomous mobility of people with autism, allow to intercept many other vulnerable inhabitants with negated and unrecognized spatial needs and desires, such as elderly people, children, women and in general groups of people who have an "atypical" way of functioning (Terzi, 2011). In conclusion it is not possible, nor desirable, to reduce the richness and complexity of the city to a sum of targeted actions. However, we do believe that the requirement of taking into account the specific needs of the most vulnerable groups of citizens, according to a multidisciplinary approach, represents not only a challenge for specialists in the fields of health and urban planning, but it is also a sustainable not-homologating way to enhance and sustain that richness and complexity thus improving the overall quality of urban life.

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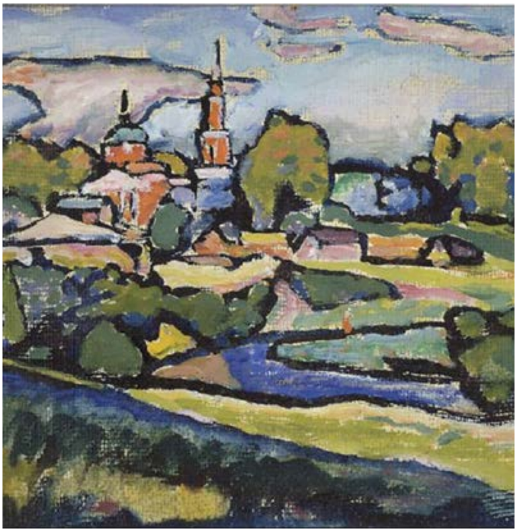

BIOURBANISM

THE ROLE OF ENVIRONMENTAL SYSTEMS IN URBAN REGENERATION PROCESSES

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ABSTRACT

The biourbanism was born to promote the exchange of information and to encourage new studies on territory and especially on the development of the environmental and social aspects of the urban systems. The territory and, in particular, the cities, must return to be actual place of relationships between human beings. For this reason, the interdisciplinarity of the analyses (ecology, biology, cognitive sciences, sociology, etc.) is of vital importance. In fact, in order to understand the essence that characterizes the complex interactions of the places and with the purpose to recover the necessary coherence to define suitable actions of design, an integrated analysis of the "existing vital orders" is necessary. It is aimed at the activation of processes able to produce a harmonica efficiency and the improvement of the quality of the life for the inhabitants. Such themes characterize the politics of urban regeneration. They allow reuniting the urbanized areas with the surrounding environment with both environmental and ecological, as well as social and cultural benefits. The general aim, therefore, consists in defining new strategies that suit the specific territorial context and determining a lasting balance between the actual resources and the future demand utilization, connecting the environment with the human comfort by actions that increase and reinforce what really exists and stimulate the vital quality of the places.

KEYWORDS

Urban Regeneration; Environmental System; Integrated Analysis; Smart Land

1 THE TERRITORY AS A SET OF INTERCONNECTED LEVELS: A BIOURBANISTIC APPROACH

Despite respect for environmental values having been a highly sought-after requirement in urban planning for years, the result of numerous interventions on the territory has been the construction of places, in this respect, unsustainable, sometimes illogical, and often degraded. Biourbanistics was created to encourage the exchange of information aimed at promoting renewed studies on the territory and, in particular, the enhancement of the environmental and social aspects of urban systems, as a new rule to be taken as a model in planning processes. This new declination of urbanism has as the primary objective of making cities again an effective place for relations between human beings, thus responding to the desire to overcome some unsatisfactory and now historicized methodological and implementation limits as well as to codify new approaches to urban planning problems. Specifically, the definition of the discipline determines the object of its analysis in the territory seen as a "hypercomplex system, consisting of a multiplicity of interconnected levels that mutually influence each other in a non-linear way, inducing the emergence of overall unpredictable properties through the study of the single parts, but only from the dynamic analysis of the whole" (Caperna et al., 2010). Overcoming the concept of space designed by sectors, biourbanistics aims to transform the city into a compact urban ecosystem that is homogeneous and vital. In particular, "life" as a design criterion has a double meaning (Serafini, 2016):

- *methodological*, since biourbanistic planning is inspired by life sciences in dealing with its own object in terms of complexity, both analyzing it and constructing it;
- *content*, as at different scales of definition, measured in physiological, neurological, sociological and ecological terms, it detects the processes capable of producing systemic efficiency and quality of life for the inhabitants.

The territory, in general, and cities, in particular, are considered as vital systems, organisms the morphological complexity of which must be recognized in order to be able to break down the non-linear dynamics that are established and predict the effects that can affect them. Therefore, this reformulation implies the adoption of a methodology based on the theory of complexity, that is structured on an interdisciplinary study model of the emerging systems[1] and phenomena associated with them. This approach makes it possible to open up to new methods of physical reading of the urban structure and to a different interpretative key to sustainability. Therefore, in order to understand the essence characterising the complex interactions of places and recover the coherence necessary to define adequate project actions, an integrated analysis of the "existing vital orders" is necessary, aimed at activating processes capable of producing a harmonious integration between the environmental and urban aspects and the improvement of the quality of life for the inhabitants. It is, itn other words, he pursuit of *sustainable development* by focusing on the compatibility of the changes made to the territory with the characteristics of the environment, respecting and conserving natural resources.

[1] With system, we refer to a permeable structure, whose elements are characterized by a series of relationships and dynamic interconnections that occur both towards the internal environment and towards the outside.

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2 ENVIRONMENTAL ASPECTS AS COMPONENTS OF SUSTAINABLE DEVELOPMENT

The principle of sustainable development, widely disseminated and shared in different fields of study, was contained, for the first time, in the Brundtland report[2] which, emphasizing the protection of the needs of all individuals, defines sustainable development as: "a development that meets the needs of the present without compromising the ability of future generations to satisfy their own" (WCED, 1987).

Subsequently, the meaning of sustainability has been taken up and adapted to several disciplinary sectors, modified and deepened according to the context of application. The present contribution, however, does not intend to analyse the evolution of the term in its different meanings, but rather to explore, in a biourbanistic approach, the multidimensional nature of interrelation between three levels: economic development, environmental protection and social development. These three spheres have been widely reported in the literature, especially following the Johannesburg Sustainable Development Declaration, which states that sustainable development is the result of the integration of these three dimensions: economy, environment and society (WSSD, 2002).

Fig. 1 The three components of sustainability. The area resulting from the intersection of the three components coincides, ideally, with sustainable development; the intermediate intersections can be read as indications of an operational or verification type.

Each dimension aims at the pursuit of a specific objective, respectively:

- *economic*, intended as the capacity to generate income and work for the livelihood of the population;
- *environmental*, intended as the capacity to maintain quality and reproducibility of natural resources;
- *social*, intended as the capacity to guarantee a condition of human well-being equally distributed by class and gender.

Environmental protection, therefore, represents just one of the fundamental principles of the broader objective of sustainable development which, specifically, contributes to the creation of borders between which sustainability strategies must move compared to the other two dimensions. The expression ‘environmental sustainability’ is often associated with the term ‘ecosystem’, intended as the natural environment capable of maintaining its properties unaltered in relations with space and time. For this reason, the themes of sustainable development and of environmental development have regarded the disciplinary debate linked to urban and territorial studies, playing a considerable role for the organisation of strategies which are at the base of transformation processes (Newman & Jenning, 2008). Cities and territories need to face the challenges of sustainable development, based on the complexity of interacting perspectives and taking into account existing resources and their mutual relationships (Kirdar, 2003). Contemporary cities especially, in continuous and rapid expansion, at times without the effective action of

[2] The document was created document was drawn up in 1987 by the World Commission on Environment and Development, established following a resolution by the United Nations General Assembly.

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conventional instruments of urban growth guidance and control, have become the place where transformations are more marked, environmental degradation is more visible, life quality is lower, and diversity and phenomena of marginality produced are more evident. The ecological crisis and the social issues are therefore increasingly evident among the structural problems of modernity.

3 URBAN REGENERATION AS INSTRUMENT OF ENVIRONMENTAL SUSTAINABILITY

Based on the above, the integrated approaches for decision support for urban planning and design are those that, to date, can contribute more to the production of more efficient and effective results compared to sectoral approaches and, at the same time, are able to work in a decision space that is multidimensional and intersectoral (Wiek & Walter, 2009). To obtain appropriate feedback on the plan of urban policies, it is necessary to emphasize the transition from urban expansion cycles to regenerative cycles, in which appropriate civil, productive and environmental values can find space. Some research identifies a possible tool for orienting urban transformations towards criteria of environmental sustainability in regeneration interventions. These practices, aimed at protecting the environment, the landscape and limiting soil consumption, can improve our cities, deepening research on the processes of transformation and management of resources within an innovative design of the urban environment. The reuse of abandoned urban land, the reconversion of abandoned buildings, the reduction of the demand for new urbanizations, the increase in attractiveness, services and places of aggregation in the dense city are just some of the cornerstones of urban planning practices aimed at building a sustainable city (Couch & Dennemann, 2000). They are solutions which are capable of indicating, developing and supporting sustainable policies in the search for a long-lasting balance between social, environmental and economic interests. Urban regeneration represents, in this sense, an opportunity to solve problems, such as the lack of neighbourhood identity, the lack of public spaces and high density, through interventions aimed at solving both physical and environmental degradation as well as exclusion and marginalization phenomena, enhancing the present social capital and paying great attention to the collective and economic fragilities of minorities and cultural identities. These topics, distinguishing themselves from urban renewal processes linked solely to the physical redevelopment of parts of the city, allow the reunification of urban areas with the surrounding environment with consequent environmental, ecological and social and cultural benefits. Therefore, they represent a priority condition of development for the coming years, for which a comprehensive strategy is indispensable, guaranteeing good levels of quality, minimum environmental impact and energy savings. Innovative strategies, proposed in national and international contexts refer to programming processes aimed, in particular, at the social and environmental components, preventing local development in relation to the effective use of resources and strategic planning objectives for the verification of the effectiveness of the results achieved. Urban regeneration thus defines a complex relational system that involves all the resources present and available on the territory, as well as their rational and efficient use, according to transversal and multidisciplinary connections.

4 SMART TERRITORIES AS REGENERATION OBJECTIVES

In order to analyse the function effectively performed by urban regeneration interventions in the construction of the sustainable city and, specifically, the effects that such processes trigger on the entire urban plant with particular regard to the environmental system, this contribution deepens some methodological aspects in order to increase the effectiveness of transformations by orienting them towards

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sustainability models. For each context, the starting point consists of identifying, the same as for living beings, the corresponding and specific genetic code: a set of rules designed to achieve the most appropriate relationships and configurations that determine the presence of vitality. Urban space, in accordance with biourbanistic principles, is therefore intended as a living entity which, like biological forms, must possess complexity, diversification, articulation and geometrical, relational and functional characteristics that are well defined (Alexander, 2002). The urban project must contribute to enhancing the following properties: hierarchies, gradients, perceptibility, recollection, openness and external vision, characterized boundaries, attracting nodes and elements, presence of activities and equipment, interpenetration and dialogue with buildings, continuity and connection with other public spaces, good microclimate, and appropriateness to the site (Salingaros, 2005). Redesigning and rethinking life in large urban centres according to this perspective is a development paradigm typical of the concept of *smart city*, the intelligent city, declined in a territorial key becomes *smart land*: a new frontier of urban regeneration policies and integrated development of territories. It is a unique representation including aspects which are usually addressed separately, analysing the city and the territory as a unique ecosystem, a set of interconnected levels and, therefore, in accordance with the approach proposed by biourbanists. On a territorial scale, reference is made to a system that, based on the intelligent use of new technologies and on a functional network between economic and social actors, can guarantee the production of more services with fewer resources. For this reason, when we talk about *smart cities* or *smart land*, we have sought to underline sustainability on the environmental side. The concept of *smart land* brings with it an idea of growth and awareness of the territory, as the first place from which to start and on which to try to graft an ever closer integration between development, technological innovation, environmental sustainability and identity.

In fact, the expression *smart land* indicates a territorial field in which, by means of diffused and shared policies, the territory's competitiveness and attractiveness increases, with a particular attention to social cohesion, to the spread of knowledge, to creative growth, to accessibility and freedom of movement, to the usability of the natural, historic-architectural, urban and diffused environment, and to the quality of the landscape and of the inhabitants' quality of life (Bonomi & Masiero, 2014). The concept of *smart land* is one which allows a sustainable, intelligent and inclusive territory to be placed in a network. A *smart land* is an identitary place in which all the local systems (environmental, cultural, economic, landscape) find their territorial dignity, through a convenient revaluation of the supply system that uses advanced systems to promote routes and themes that enhance specificity and increase both the added value and the perceived value. Attention to the environment is not only reflected in the preservation of its appearance, but in the improvement of the processes that enhance it (such as waste management, pollution limitation, reduction of private traffic, territorial redevelopment) according to models oriented towards the improvement of the quality of life and places, encouraging the saving of land and reclaiming abandoned areas in order to improve the territorial offer and the usability of the places.

5 CONCLUSIONS

The theoretical-scientific assumptions that biourbanism makes allow positive practical-applicative implications on the territory. Specifically, as mentioned before, the prevailing theoretical-scientific objective is aimed at providing a real space to profound ecology (Bateson & Longo, 1984), improving the ecosystem and providing a better understanding how cultural and physical factors in urban reality interact influencing the well-being of citizens. Its practical-applicative result is that of bringing urban planning to the centre of a

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new civilization in its primal sense, establishing an alliance between the urban system and the environmental system in order to generate a lasting systemic interaction.

Recalling the meaning of sustainable development as a guarantee for future generations of having the same possibilities as present ones, as well as protecting the environment from actions and omissions that could damage it irreparably, the reference to the idea of regeneration scenarios, based on a reading of the effects of the project on the urban system and on the more specific analyses of the repercussions that physical transformations have on the environmental system, is evident.

In this sense, the general objective of the research is based on the need to implement innovative action strategies that bring specific urban contexts closer to the concept of smart land, realizing, through the definition of a territorial regeneration plan, a lasting balance between the availability of current resources and the envisaged demand for future use, that is, connecting the environment with human well-being. In particular, the future research developments will have the Calabrian territory as their field of implementation; its training process has favoured the development of multiple bio-diversities and socio-diversities. Starting from the assumption according to which often the predominance of the economy and its rules is due to the widespread degradation of environmental and social systems, and taking note of the local potential of these two systems in the Calabrian territory, the research is oriented to reverse the process, namely to understand how the enhancement of these two systems could have positive repercussions on the economic one.

In conclusion, starting from an analysis of the current urban regeneration practices, according to the biourbanistic approach and, therefore, with particular awareness of the possible environmental resonances, we aim to intervene on a wider territory in physical and functional terms, through the preparation of actions that integrate incrementally, stimulating the intrinsic vital qualities of the places.

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ENVIRONMENTAL CRITERIA

CONSISTENCY BETWEEN THE MINIMUM ENVIRONMENTAL CRITERIA AND THE ITACA PROTOCOL CRITERIA CONCERNING THE QUALITY OF THE INTERVENTION SITE

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ABSTRACT

During the last years, many studies analysed the environmental issue in the buildings sector by providing useful criteria to reduce its impact on urban systems. In this regard, also in Italy the legislator provided an important direction by introducing the optional "Minimum Environmental Criteria (MEC)" that progressively became binding for all public buildings. In particular, the standard opened a new phase in the request and verification of these criteria. In fact, the performance field includes also the environmental part, while previously the design focus was based only on the energy performance of building systems.

In this context, the reference to energy-environmental certification systems and their use as a verification method for individual MEC is decisive, although not fully effective.

This paper describes the first results of a research aimed at defining some technical and administrative steps that are still unclear in this first application phase of the standard. In particular, the goal is to verify the consistency between the binding regulatory provisions (MEC) and the most widespread voluntary environmental certification system in Italy, the ITACA protocol, arriving to define a methodology of integration.

KEYWORDS

Environmental Sustainability; Certification Systems; Minimum Environmental Criteria; Quality of the Intervention Site

1 INTRODUCTION

In recent years, many studies have developed the environmental matter in the construction sector by providing useful criteria to reduce environmental impact (Gandolfi et al., 2014). Also in Italy, legislators have provided an important indication on this topic, introducing the Minimum Environmental Criteria (MEC) (Law n. 221/2015) which, from being optional, has become more constraining for all public constructions. In particular, the Ministerial Decree for the Environment of 11 October 2017, "*Minimal environmental criteria for the entrusting of design and works for new construction, refurbishment and maintenance of public buildings*"[1] has launched a new phase in the demand for and verification of such criteria. In fact, if before the design focus was mainly based on the energy performance of building systems, with the aforementioned Decree, the performance field is extended also to the environmental aspect. The sustainability criteria contained in the Decree provide specific techniques useful in guaranteeing conservation of the environment in the intervention area, as well as increasing energy efficiency for the reduction of energy consumption. In this context, the reference to energy and environmental certification systems and their use as a verification method for individual MECs is crucial, although not fully effective. This paper describes the first results of a research aimed at defining some technical and administrative steps that are still unclear in this first application phase of legislation.

2 BINDING AND VOLUNTARY ENVIRONMENTAL ASSESSMENT SYSTEMS

The main objective of the MEC is to provide all the stakeholders in the building process with guidance on reducing environmental impact, from design to construction, by facilitating monitoring activities and facilitating the potential bidders, as the environmental characteristics required by the contracting authority are immediately evident. The sustainability criteria set by the standard, related to planning, refer to all levels of design (from the preliminary to the final and executive) and to all the scales (from groups of buildings to the building component). In particular, we provide "indications and technical prescriptions" useful to guarantee the conservation of the habitat of the area of intervention, guaranteeing the physical interconnection to habitats outside the intervention area, which are useful in improving energy efficiency.
Therefore, the designer must make technical draft choices and provide the technical documentation that will allow these criteria to be met. Together with the requirements of minimum environmental standards, there are also numerous, and already established, voluntary environmental certification systems (Kohler, 2017). Among these, the most widespread in Italy is the Itaca Protocol (Regione Calabria, 2016): a tool for assessing the level of energy and environmental sustainability of buildings, which allows the performance of a building to be assessed in reference not only to consumption and energy efficiency, but also by taking into account its impact on the environment and on human health. The present work is inspired by an application case that has had as its object the refunctionalization of some public housing buildings in the City of Lamezia Terme (Calabria, Italy), and is aimed at the integration of regulatory provisions (MEC) with the procedures of voluntary environmental certification (Itaca). For this intervention, compliance with the MECs was

[1] The DM is an integral component of the "Action plan for environmental sustainability of public administration consumption" and also takes into account the proposals in the Communications of the European Commission COM (2008) 397 on "Sustainable production and consumption sustainable industrial policy ", COM (2008) 400 on" Public procurement for a better environment "and COM (2015) 615" European Union circular economy action plan "adopted by the Council of Ministers of the European Union.

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mandatory, as well as achieving, on a regional basis, the energy and environmental certification of the buildings envisaged by the Itaca Protocol. The decree introducing the MEC provides that, if the project is submitted simultaneously to a verification phase valid for the subsequent certification of the building according to one of the protocols of energy-environmental sustainability of buildings (rating systems) at national or international level, compliance to each criterion can be demonstrated if all the requirements are traceable to the environmental performances referred to by the criterion in the certification. In such cases the planner is exempt from the presentation of documentation relating to the MEC. It is sufficient to present the documentation required by the specific certification protocol for sustainable construction used which, in this case, is Itaca.

At present, however, MEC and Itaca are not comparable. In consideration of this, the designers of the application case had to draw up both assessments and complete two separate reports, although both were intended to obtain the same result: energy and environmental sustainability. We must also consider that, with the introduction of MEC, the approach to design sustainability, construction, redevelopment and management of buildings is sometimes very laborious, as the legislator has provided the requirements, but has not suggested a methodology. The result is so complex and contradictory that it becomes almost unworkable, certainly in its entirety. On the other hand, a more effective action could have been achieved, during the creation of the standard, by covering a process of development and sharing with the procedures of environmental certification systems which, by their structure, offer methodologies capable of quantifying the levels of sustainability, using inspection bodies to verify compliance with environmental performance.

Starting from this reflection, the paper illustrates a methodology aimed at comparing the two systems, highlighting the differences in terms of the conditions required, and a possible solution to streamline the verification procedure. In particular, the method adopted includes:

- the comparison between the criteria envisaged by both systems;
- the definition of the alignment of the environmental certification procedure with the MEC;
- the review of the Itaca protocol criteria forms to make them "compliant" with MEC contents.

Below, we describe the first results related to the thematic area concerning "Site Quality", designed to verify the conditions of localization of the project intervention and of insertion in the territorial context, with reference to the Calabrian region.

3 COMPARISON OF ENVIRONMENTAL REQUIREMENTS FOR SITE QUALITY

The two systems under consideration show very different levels of quality and performance for some criteria. Moreover, their very nature is also different.

<u>Minimum Environmental Criteria</u>

MECs are mandatory and binding, and consist of rules to be followed during the design phase, divided into basic criteria and reward criteria. While the latter are integrated in the procurement documents in the event that the contract is awarded on the basis of the most economically advantageous offer, the basic criteria are mandatory. With particular reference to the "Site Quality", the basic Minimum Environmental Criteria are:

- 2.2.1 Naturalistic and landscape insertion;
- 2.2.2 Arrangement of green areas;
- 2.2.3 Reduction of land consumption and maintenance of soil permeability;
- 2.2.4 Conservation of morphological characters;

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- 2.2.9 Secondary infrastructures and sustainable mobility.

The first criterion aims to guarantee the conservation of the habitats present in the intervention area; the second provides requirements for green areas with the aim of encouraging interventions and actions that also guarantee the subsequent maintenance and management phases; the third criterion contributes information and requirements useful for containing urban sprawl; the fourth criterion tends to guarantee the maintenance of the existing morphological profiles; finally, the last criterion provides information and requirements to guarantee an adequate functional mix, as well as accessibility to public transport.

<u>Criteria of the Itaca Protocol</u>

The ITACA Protocol offers the possibility of evaluating the environmental sustainability of the actions through an objective analysis and to compare the result with other contributions (Cumo et al., 2015). In itself, it is a voluntary document, but Regions that have imposed its use, including Calabria, have made it mandatory in order to obtain incentives and facilitations. The criteria relating to the evaluation area concerning the "Site quality" refer to a series of urban and landscape parameters that also include the spaces belonging to the building / building complex and the related equipment (IISBE, 2011):

- A.1.5: Reuse of the territory;
- A.1.6: Accessibility to public transport;
- A.1.8: Functional mix of the area;
- A.1.10: Adjacency to infrastructure;
- A.3.x: Integration with the urban and landscape context;
- A.3.3: Outdoor areas equipped for shared use;
- A.3.4: Support for the use of bicycles;
- A.3.7: Handling of open spaces with vegetation belonging to native species.

The first criterion, which refers only to new buildings, aims to reuse the territory; the second criterion is aimed at encouraging the use of public transport; the third criterion checks the presence of an adequate "functional mix" of secondary urbanization works around the intervention site; the fourth criterion refers to the adjacency to infrastructures of primary urbanization; the fifth criterion has the purpose of encouraging the harmonization of the building with the surrounding elements and landscape; the sixth criterion verifies the quantity and quality of the spaces intended for aggregation activities within the areas relevant to the intervention; the seventh criterion aims to encourage the use of the bicycle as a means of transport; while the last one aims to favour the ecological and formal continuity of the site through the conservation, enhancement and growth of native tree and plant species.

4 PROCEDURE FOR CRITERIA ALIGNMENT

The alignment procedure was developed by identifying the exact differences between the individual criteria. The results are shown in the following Tab.1.

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MEC	ITACA PROTOCOL	DIFFERENCES AND POSSIBLE ADDITIONS
2.2.1 Naturalistic and landscape insertion	Criterion A.3.x Integration with the urban and landscape context	The criteria for the conservation of habitats and the criteria to protect the interconnection between the areas must be defined by a qualified professional registered in professional registers, who possess proven experience in the environmental field, which can be evaluated on the basis of the professional suitability requirements and of technical-organizational capacity requested from time to time by the contracting authority. The project must also indicate a selection of the arboreal and shrub species to be planted in these areas, taking into account the absorption capacity of pollutants in the atmosphere, the regulation of the microclimate and using species that have the following characteristics: reduced water requirement, resistance to plant diseases and absence of harmful effects on human health.
2.2.2 Arrangement of green areas	Criterion A.3.7: Vegetation treatment of open spaces belonging to native species	During repairs to the structure, techniques of maintenance of the existing green heritage should be envisaged with inspections prior to the flowering stage in order to avoid the spread of pollen. When selecting plants, the following guidelines must be followed: use native species with low or non-allergenic pollen; in the case of moderate to high allergenic pollen, favor female or sterile plants; favor entomophilous pollination plants, that is, those which produce small quantities of pollen whose dispersion is entrusted to insects; avoid stinging or spiny or toxic species; use herbaceous species with a deep root system to ensure the stabilization of green areas with steep slopes and subject to superficial landslides; do not use tree species with a fragile root system, or with weak stems or branches that could cause damage in the event of intense weather events.
2.2.3 Reduction of soil consumption and maintenance of soil permeability	Criterion A.1.5: Reuse of the territory	The design of new buildings or urban renovation projects, without prejudice to the most restrictive rules and regulations, must have the following characteristics: new buildings or increases in volumes of existing buildings cannot be planned in protected areas of any level nor kind. a permeable territorial area of not less than 60% of the project area has to be available; a surface to be allocated to green equivalent to at least 40% of the surface of the undeveloped project and 30% of the total area of the lot has to be available; in public green areas, tree crown cover has to be at least 40% and shrub lands with native species at least 20% favouring the plant species that have predominantly entomophilous reproductive strategies or that produce small amounts of pollen whose dispersion is entrusted to insects; use of materials for drainage in urbanized pedestrian and cycle surfaces; the obligation also extends to vehicular areas in the field of environmental protection; in the final project, the construction of a drainage system of at least 60 cm in the areas for which excavations or drain covers are planned. The drainage system must be set aside on site so as not to compromise its physical, chemical and biological characteristics and be reused for green spaces on modified surfaces.

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MEC	ITACA PROTOCOL	DIFFERENCES AND POSSIBLE ADDITIONS
2.2.4 Conservation of morphological characters	Criterion A.3.x: Integration between the urban and landscape context	Fully matching
2.2.9 Secondary infrastructures and sustainable mobility	Criterion A.1.8: Functional mix of the area Criterion A.1.6: Accessibility to public transport	The design of a new group of buildings, notwithstanding the most restrictive rules and regulations, must guarantee the following simultaneous performances and provide for the following actions to guarantee these services: - implementation of public services less than 500 m from housing, in the case of residential projects; metro stations less than 800 m and/or railway less than 2000 m from the new complex (transport service has to allow bicycle transport), where there are no stations less than 800m away, there have to be frequent shuttle services and distribution of journeys during peak/off-peak times in line with real use scenarios; racks for bicycles at the interchange stations with the public transport service and the major places of interest; public transport stops have to be less than 500 m from the houses (road transport must ensure at least a distribution of rides during peak/soft hours commensurate with the real scenarios of use by users and allow the transport of bicycles); adequate network of protected cycling and pedestrian routes (both from physical harm and by pollution) and with adequate tree and/or bushes that can also be used as a shelter to reach the stations.

Tab. 1 Differences between criteria

5 REVIEW OF THE ITACA PROTOCOL CRITERIA SHEETS

Starting from the differences highlighted, we proceeded to modify the Itaca Protocol criteria sheets to integrate, where necessary, the most binding MEC requirements. Below is one of the modified sheets relating to criterion A.3.7 "Vegetation treatment of open spaces belonging to native species" (Fig. 1).

Specifically, the provisions relating to the maintenance of green areas set out in part in the "2.2.2 Green areas" MEC and, in part, in MEC 2.2.3 "Reduction of land consumption and soil permeability maintenance. With reference to the latter, in order to guarantee 20% of the area planted with native species, the performance scale of the Itaca criterion was also modified, which imposed a minimum benchmark that was much less restrictive than the limit imposed by the MEC.

6 THOUGHT PROVOKING POINTS

The methodology described goes in the direction of streamlining building processes as much as possible, while at the same time ensuring a high level of project quality in terms of urban sustainability.

In view of the fact that MECs are now an existing standard, and that their modification seems unlikely, it would be desirable for the authors of the environmental certification systems to take on the alignment procedure. This is especially important when considering that MECs are applied to groups of buildings and that a new set of criteria for environmental certification on urban scale is currently being defined.

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Criterion A.3.7 - Vegetational treatment of open spaces belonging to native species

The criterion intends to evaluate the degree of use of native trees and plants with low allergenic power in the arrangement of the external areas belonging to the building.

REQUIREMENT	CRITERIA IMPORTANCE	
Promote the ecological continuity of the site and encourage actions that also guarantee the subsequent maintenance and management phases.	In the category	in the whole system

PERFORMANCE MEASURE	UNIT OF MEASURE
Percentage ratio between the areas planted with arboreal plants and native plants and the total external area that belongs to the building	%

PERFORMANCE SCALE

	%	POINTS
NEGATIVE	**< 20**	**-1**
SATISFACTORY	**20**	**0**
GOOD	**25**	**3**
OPTIMAL	**30**	**5**

Method and resource assessment

The assessment of the criterion involves the following procedure:

1. Report, in a special specialized report, the list of autochthonous tree and plant species typical of the geographical region of the project (according to the Regional Law n.47 / 2009), with particular reference to those present in the lots and other areas adjacent to the lot affected by the intervention.

2. Identify, in the project plans, within the external areas of relevance, the exact delimitation of the area to be planted with native trees and plants, taking into account the following requirements:

• use native species with low levels of allergen substances;

• in the case of moderate to high allergenic substances, favor female or sterile plants;

• favor entomophilous pollination plants, which produce small quantities of pollen whose dispersion is entrusted to insects;

• avoid species that are toxic, sting, or are with thorns ;

• use herbaceous species with a deep root system to ensure the stabilization of green areas with steep slopes and subject to superficial landslides;

• do not use tree species with a fragile root system, or with weak stems or branches that could cause damage in the event of intense weather events.;

• adopt techniques for the maintenance of existing green heritage with control interventions prior to the flowering period in order to prevent the spread of pollen.

3. Calculate the total area of the external surfaces that belong to the intervention (A);

4. Calculate the area of the planted surfaces with native trees and plants in the external areas of relevance (B);

5. Calculate the percentage of areas planted with native tree and plant species compared to the total area of the intervention: B / A x 100.

6. Verify that B / A x 100 is 20%.

7. Choose among the proposed scenarios what best describes the characteristics of the intervention in question.

Fig. 1 Integrated criterion form

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IMAGES SOURCES

Cover image: https://www.saint-gobain.it/aggiornati-i-cam-criteri-ambientali-minimi-l%E2%80%99edilizia

Fig. 1: Authors' elaboration

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G3W-SUITE, PUBLISHING AND MANAGING CARTOGRAPHIC QGIS PROJECTS ON THE WEB

THE USE IN "FORESTE CASENTINESI, MONTE FALTERONA E CAMPIGNA" NATIONAL PARK

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ABSTRACT

G3W- SUITE is a modular, client-server application for managing and publishing interactive QGIS cartographic projects of various kinds in a totally independent, simple and fast way. Accessing administration, consultation of projects, editing functions and use of different modules are based on a hierarchic system of user profiling, open to editing and modulation. Its main components are the one for basis administration, G3W-ADMIN, and the visualisation client for cartographic contents G3W-CLIENT. They communicate through a series of API REST which makes them totally interchangeable. G3W-ADMIN was developed through Python, using Django while Python language was chosen for the easy possibility of developing various modules. The Cartographic Service of "Foreste Casentinesi, Monte Falterona e Campigna" National Parks uses this suite to publish its cartographic information about: administration plans; habitat, geo-site and vegetation maps; monumental trees map; bats, reptiles and amphibian species distribution. The maps can be used by researchers to study the distribution of the different species in relation to vegetation and habitat distribution. The suite is used to simplify the making of "nulla osta" acts thanks to the possibility of uploading vector layers (.shp or kml) on the webgis and to make intersection operation "on the fly". The suite also allows to take geo-note (with integrated photo) directly on the map using tablets and to collect data directly on webgis thanks to the on-line relational editing module.
G3W-ADMIN and G3W-CLIENT modules are released on GitHub with Mozilla Public Licence 2.0

KEYWORDS
Park; Environmental Management; QGIS; WebGis

1 INTRODUCTION

The collection of naturalistic data, and their consequent management and organization to allow fruition and analysis, is a fundamental part of the life of a National Park. Considering the responsibility the Park Authority takes on as regards preservation and monitoring of biodiversity, especially relating to those species of community and preservation interest, and considering the present availability of numerous naturalistic data, acquired through years of research on the territory, the question of how to manage and organize such information is more and more urgent, as is its sharing with other public entities and with the citizens.

At the moment, thanks to the use of new technologies, such as computer and internet, filing and fruition of information can be much faster and more dynamic. The data that Foreste Casentinesi, Monte Falterona e Campigna" National Park has been collecting for years, through surveys and research on the territory, need today a uniform and rational organisation, so that they can be used in a practical and quick way in connection with the preservation and the managing of nature and its resources. At the same time, the continuous updating and expanding of this information is vital to the monitoring of actions which have already been undertaken.

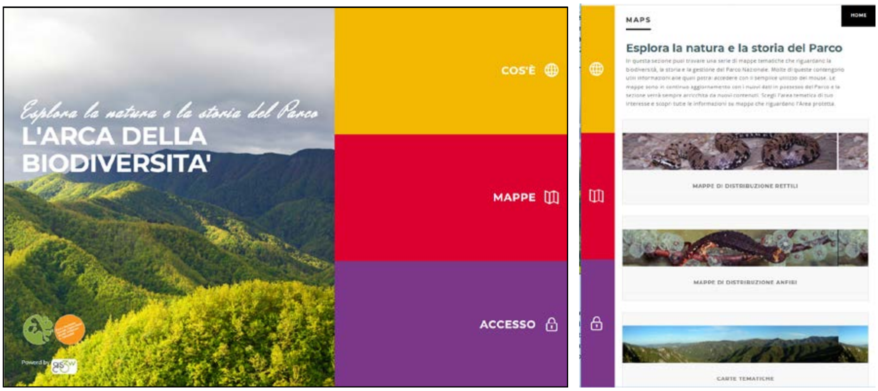

Fig. 1 Portal homepage

The tool which at the moment best represents an answer to these needs is that of web – based Geographic Information Systems (webGIS). These softwares work together with the possibility of managing data bases which are geo-referenced to web usage. Thanks to the web, they can be shared and constantly updated by more than one user. Besides allowing easier and faster consultation and updating by specialised operators, these tools open up the possibility of directly involving the citizens in themes of special interest to the Park Authority. The main goal of a management project for these databases, then, must be that of collecting and rationalising all information the Park owns through an on-line geo-database tool which can allow its continuous updating by more users, authorised in real time. That is why the various naturalistic databases, descending from studies and researches inside the Park, have been levelled out, updated and implemented by collecting all available information and integrating it into a tool which allows them to be shared and continuously updated in an efficient and direct way. At the same time, the general public has been involved by sharing with it part of the collected data, as regards specific projects, through the building of a specific webGIS, where users can monitor status and distribution of target species. The possibility of direct access

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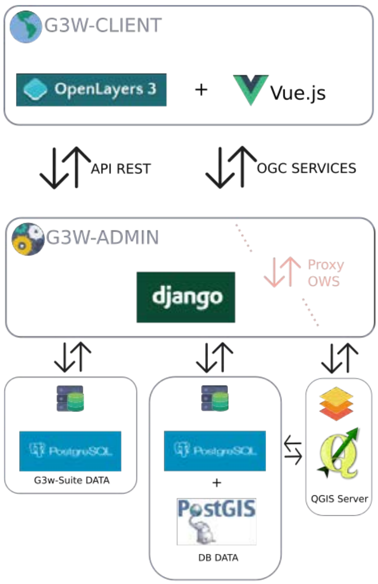
and consultation by the common citizen will allow greater involvement and awareness in relation to the safeguarding of nature inside the Park.

2 G3W-SUITE: APPLICATION FEATURES

G3W-SUITE is a modular, client-server application for managing and publishing interactive QGIS cartographic projects of various kinds in a totally independent, simple and fast way.
The application can organise cartographic contents in a hierarchic way, helping the content management in



structured contexts, such as public institutions, parks, companies etc. Accessing administration, consultation of projects, editing functions and use of different modules are based on a hierarchic system of user profiling, open to editing and modulation. Its main components are the one for basis administration, G3W-ADMIN, and the visualisation client for cartographic contents G3W-CLIENT. They communicate through a series of API REST which makes them totally interchangeable. G3W-ADMIN was developed through Python, using Django, a trustworthy, solid framework, which can be found at the basis of various GIS projects such as GeoNode, while Python language was chosen for the easy possibility of developing various modules. G3W- CLIENT was developed using a modular approach and is based on a "reactive programming" paradigm, being thus able to create an interface which can adapt to the managing of the various modules included in G3W-SUITE (printing, research, editing etc) and of future ones, in a simple, clear way for the final user. We used Vue.Js like Javascript framework, for the simple approach towards "reactive" programming and for its flexibility and freedom of integrating it with other libraries. The rendering of geographic data is based on *OpenLayer3*, for

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its simple and advanced functions in the managing of the map and its layers; the possibility of creating functions allowed the development of advanced editing tools and the creation of complex styles.
Functional modules for data managing (geo-note and multi-user relational editing) can adapt to the needs of many PAs and multi-utility companies. G3W-SUITE and, in particular G3W-ADMIN and G3W-CLIENT modules, are released on GitHub with Mozilla Public Licence 2.0

3 THE PARK WEBGIS SERVICES

The Park authority has developed its own web-gis project for managing cartographic information and naturalistic databases, through Gis3w application. Use of Qgis has allowed the setting of a geo-database aimed to facilitate sharing of information both inside the Authority and between it and Carabinieri Forestali. At the same time, Gis3w app has helped divulge information, after a careful evaluation of sensitive data. The disclosure of these data and information was possible thanks to the publication of the portal biodiversita.parcoforestecasentinesi.it, called "L'arca della Biodiversità" (Biodiversity Ark), where thematic maps about different naturalistic aspects (vegetation, habitat, geo-sites) and territorial aspects (zoning, nature 2000 sites, hiking, administrative borders) of the Park have been published. On the same portal, maps regarding the distribution of some species groups, such as reptiles, amphibia and chiroptera, have been published to present the rich biodiversity of the Protected Area. The disclosure of these data was possible thanks to a fine operation of levelling out and standardisation of databases, without which it would not have been possible to publish the data. On the portal biodiversita.parcoforestecasentinesi.it there are four different public sections, each accompanied by descriptions and clarifying texts inherent to the maps:

- thematic maps;
- Amphibia in the Park;
- Reptiles in the Park;
- Bats in the Park;

and one private section:

- nulla osta.

The thematic maps section includes 7 maps: the Park hiking map, the Nature 2000 Net Habitat map, the Geo-sites map, the Nature 2000 sites map, the Vegetation map, the Administrative borders map and a map showing the plan of the Park. It is possible to create your own print-outs (paper or digital) of excerpts from each map through the Print function. The section Amphibia in the Park includes 13 maps: one map with 2 km–by- 2 km distribution grids for each amphibian species present in the Park and one summarizing map (Amphibia in the Park atlas) indicating the number and species of amphibia inside each 2 km -by -2 km sector of the Protected Area. The section Reptiles in the Park includes 11 maps: one map with 2 km–by- 2 km distribution grids for each reptile species present in the Park and one summarizing map (Reptiles in the Park atlas) indicating the number and species of reptiles inside each 2 km -by -2 km sector of the Protected Area.
The section Bats in the Park includes 21 maps: one map with 2 km–by- 2 km distribution grids for each of the main bat species present in the Park and one summarizing map (Bats in the Park atlas) indicating the number and species of bats inside each 2 km -by -2 km sector of the Protected Area. All above sections have been presented and advertised through news on the web site, news letters and social networks.
The section Nulla Osta is specific for internal consultation and includes exact data on all sensitive species, in the event of building sites or forest operations needing a nulla osta by the Park Authority.

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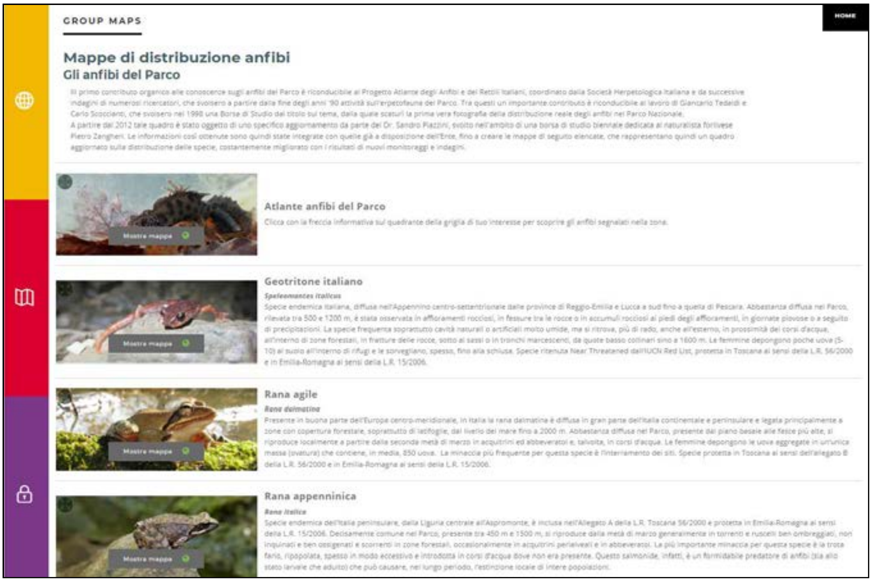

Fig. 2 Page showing distribution of amphibia in the National Park

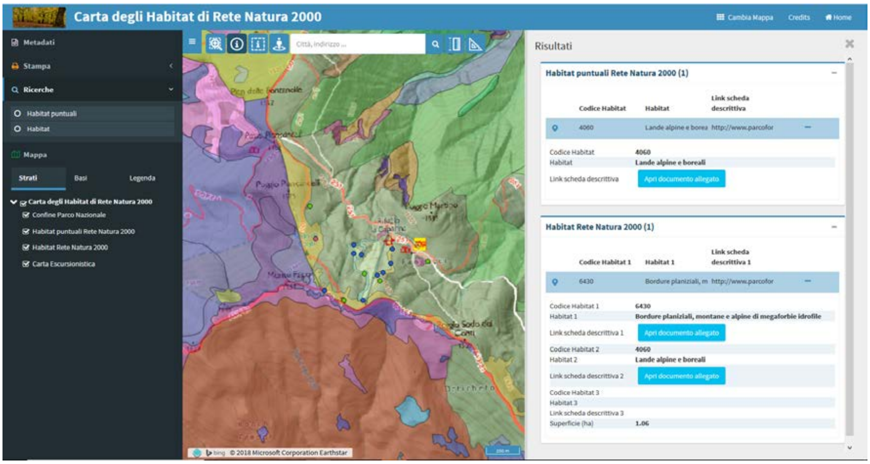

Fig. 3 Map of the Natular Network Habitat

4 FUTURE DEVELOPMENTS

The aim of this research project is that of involving the public more and more and making it possible for everyone to participate not only in the monitoring work the Park Authority has been doing for years to

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inform and promote visiting the protected area with full awareness of what it has to offer, but also indirectly in collecting some of these data through specific campaigns of citizen science. To be able to do this, new maps on distribution of animal species will be created and published on the Park webGIS, "L'arca della biodiversità":

- first of all, starting from data collected by the Italian Association for study and preservation of dragonflies (Odonata.it) during the last two years of monitoring, new maps on the distribution of almost 40 dragonfly species will be created;
- the Park Atlas of nesting birds will soon be published, too, and, to promote it and increase knowledge about the Park bird fauna, a special webGIS section, dedicated to the almost 100 bird species living in the protected area, will be created;
- eventually, the webGIS on monumental trees in the Park will be updated and included in the project "L'arca della biodiversità", to allow the public immediate access to geo-referenced information in a single, uniform and modern bank. This operation will allow filing and archiving of old data, besides promoting "Giganti di legno e foglie" (wood and leaves giants), a guidebook showing specific hiking routes to discover monumental trees and woods inside the National Park.

The potential and advantages of citizen science (Silverton, 2009) have been known for years, so the creation of a specific section, inside the Park webGIS, where users can not only monitor the status and distribution of target species, but also add information regarding personal sightings to the Park database, together with geographic reference points and images, will be one of the most important aims of this project. One of the most interesting things about all protected areas are the species included in the Attachment in Direttiva Habitat. These species must be constantly monitored as regards both their presence and distribution in the areas. That is why, at the moment, two specific LIFE projects are being developed inside the protected area: they concern, besides other aspects, two insect species which are extremely important and typical of the area and which can be easily identified by an aware public. I am talking about the cerambycidae Rosalia Alpina (object of LIFE Eremita) and about the Euplagia quadripunctaria butterfly (object of LIFE WetFlyAmphibia). To further promote the two projects and make the public aware of these themes, specific monitoring campaigns on these two species will be organized. To make these campaigns as efficient as possible, hiking guides working inside the protected area will be involved in organizing specific routes to get to know these insects and their habitats and to try and monitor their presence by putting these data in the Park webGIS platform. The results of this projects will then affect both the circulation of information concerning the Park and the collection of new data through new tools of participation, but it will also go to the benefit of the people working on the territory, who will be able to use these tools to promote and organise new and interesting events, thus expanding and diversifying their public offer.

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AUTHOR'S PROFILE

Walter Lorenzetti is a founding member of Gis3W, Django and Python server-side developer. It deals with the development of geographic web applications dedicated to the consultation and collection of geo-referenced data.

Leonardo Lami is a founding member of Gis3W, specialized in QGIS and Geo-DB. He deals with training in the management and analysis of geographical data. It is organized in the preparation and management of SIT and in integrated desktop-web solutions.

Davide Alberti, graduated in Natural Sciences, he is the technical representative of the National Park of Casentinesi Forests, Monte Falterona and Campigna for Life projects and for natualistic research and monitoring activities within the protected area. It also deals with the management of naturalistic databases and GIS applications on behalf of the Authority.

Matteo Ruocco is graduated in Natural Sciences, he is currently a scholar of the National Park of Casentino Forests, Monte Falterona and Campigna. It mainly deals with investigating hypogea sites of the Park and their fauna and the management, reorganization and publication of the naturalistic databases of the protected area using GIS applications.

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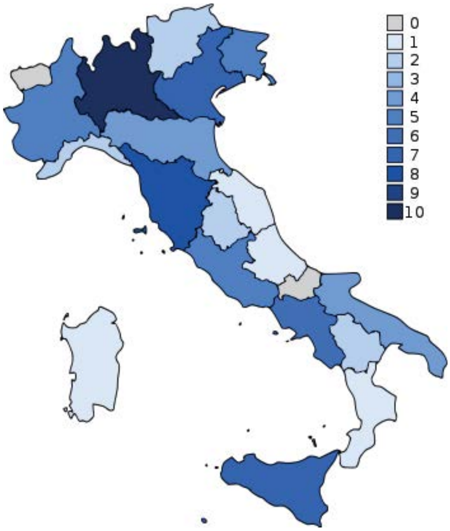

TANGIBLE AND INTANGIBLE ASPECTS IN THE PROMOTION AND FRUITION OF THE UNESCO SITES

A CASE OF SUSTAINABLE INNOVATION

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ABSTRACT

The Italian territory is complex and diversified from both the environmental-landscape and socio-cultural points of views. This is planned with traditional urban planning tools, but more and more with other kinds of non traditional ones, often supported by new technologies. Indeed, apps, web portals and so on support the promotion of sites in innovative way, creating multiple and alternative possibilities of both enhancement and fruition of places.
In particular, the Italian cultural heritage, although has its own historical tradition which make it recognizable in its entirely - above all in the visitor worldwide imaginary -, from a more internal point of view it shows profound differences of tradition, life and culture between, for example, costal and mountain places, internal areas, small villages and great historical centers, which require different modalities of promotion. For their outstanding beauty, many places were declared Unesco Heritage, but not always these are inserted in a wider contexts and planning capable to allow a suitable enhancement and fruition. Starting from these premises, the paper is aimed at illustrating the first results of a study centered on Unesco properties in Italy, in development in the framework of a CNR research – with the author's responsibility - focused on urban livability and healthy, devoted to: identify both positive factors and problems in the enhancement of these sites and the role of the Unesco acknowledgment; the contribute of Internet, web portals and apps in their sustainable enhancement and fruition. As a emblematic case study, the Dolomites site will be illustrated.

KEYWORDS

Unesco Properties; Cultural Heritage Fruition; Place Enhancement; New Technologies

1 INTRODUCTION

In recent years, the tourism system has undergone significant changes due to the rapid transformation in society, its habits and needs, and its way of understanding travel and holidays.

The development of both the Internet and social networks, the low cost transport rates, the companies to rent rooms and hotels at increasingly competitive prices have meant that visitors can organize their journey in the manner most appropriate to then and choose the destination also being guided by reviews, photos and films on the network. In addition, there is a general tendency to travel more frequently and for fewer days and, consequently, to travel at different times of the year. Demand, in terms of tastes, has become increasingly diversified, also requiring an adjustment by the supply. The demand ranges from ecological tourism to food and wine, from cultural to religious, from congress to sports, spa and wellness, just to name a few, and each of these themes has many other specific and multiple needs due to different age and family household (Icomos, 1976, 1999). There are also places that offer themselves to more than one of these specializations: emblematic are the case of Pompeii in Campania (Southern Italy), where there are both archaeological and religious tourism, well distinguished although sometimes linked in terms of visit, or the Dolomites (Northern Italy), which offer opportunities for sports, ecological, food and wine tourism etc., sometimes not connected to each other and sometimes integrated. Further occasions of visit are constituted by the great events of various kinds, such as Art Biennials, Universal Expositions, Olympics, which offer reason to visit for a certain period of time, opening to the visitor further possibility of permanence with respect to the attractions that the place possesses. This is joined by associations such as, for example, "The most beautiful villages in Italy" that promote typical villages and whose registration is subject to compliance with a Quality Charter (www.borghipiubelliditalia.it) and large organizations such as UNESCO that gives recognition to sites and places of outstanding beauty, increasing visibility and attractiveness (UNESCO, 2016). Starting from these premises, the paper is aimed at illustrating the first results of a study centred on Unesco properties I Italy, in development in the framework of a CNR research – with the author's responsibility - focused on urban liveability and healthy, devoted to: identify both positive factors and problems in the enhancement of these sites and the role of the Unesco acknowledgment; the contribute of Internet, web portals and apps in their sustainable enhancement and fruition. The emblematic case study of the Dolomiti Unesco will be illustrated[1] (Elmi & Wagner, 2013; Fondazione Dolomiti, 2015).

The collection of data is carried out with ad hoc database aimed at identifying both positive factors and problems in the enhancement of these sites and the results of questionnaires administered to users of the territories in object and relative social networks, apps, web portals etc., focused on tangible and intangible aspects of their fruition. The final aim of the whole research is the construction of guidelines for sustainable and innovative promotion and fruition of the UNESCO sites in Italy. In particular, UNESCO is committed to a broad commitment to humanity. "The United Nations Educational, Scientific and Cultural Organization, established in Paris on 4 November 1946, is committed to "Building intercultural understanding also through the protection and safeguarding of sites of exceptional value and beauty listed in the World Heritage Site". There are 53 goods declared UNESCO in Italy. Since October 17, 2003, the UNESCO General Conference has expanded this list by creating the list of oral and intangible heritage, with the "aim of safeguarding these masterpieces to prevent their disappearance, preserving the amazing set of languages, rituals, social

[1] Cfr. www.dolomitiunesco.info; www.enit.it/it/studi.html; www.unesco.it.

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customs, knowledge and practices concerning the knowledge related to craftsmanship that over the millennia have been passed down from generation to generation representing the nuances and differences inherent in the evolution of Humanity. That list includes: *L'Opera dei Pupi (Sicilia); Il Canto a Tenore (Sardegna); Dieta Mediterranea; Saper fare liutario di Cremona; Le Macchine dei Santi; Pratica agricola della vite ad Alberello di Pantelleria; La Falconeria: un patrimonio umano vivente; L'arte dei pizzaiuoli napoletani* (http://www.sitiunesco.it). In order to ensure proper management over time, in 2002 UNESCO, with the Budapest Declaration, introduced the obligation of Management Plans. The adoption of such plans has become an indispensable requirement for the entry of each new Site in the World Heritage List and it is also recommended to the Sites already included in the List in order to "ensure their conservation and create the conditions for their enhancement". The functions of the management plans are programming and coordination with respect to the interests relating to the Sites, and integrate the urban and landscape discipline of the territory (Cassatella, 2011).

2 METHODOLOGY

The modalities of place fruition are often oriented at both making a territory known and enhancing its value also through its products, building routes that are defined as experiential. One of the first examples in this sense is constituted by the paths of the typical that are turned to the valorization of local products in a logic of emphasis of their experiential dimension and of the offer of the territory of which they are expression. The sense of the paths of the typical lies in the desire to make a product known and at the same time to derive social and symbolic benefits. The Wine Roads, introduced by the national law n.268/1999 – Disciplina delle Strade del Vino, are an example of interest in this regard. The paths centered on the experience of typical products are an example of negotiation between the different activities of enhancement of resources of a territory that have as a common point the desire to integrate the supply of territory with that of the products. The involved actors, driven by the idea of directing their offer in a broader context of users, are oriented towards building a network of relationships with other producers and stakeholders participating in the initiative to promote the territory. The success of the strategy is given by the will and ability to coordinate the individual producers, from which synergy can be achieved a real creation of added value and experience of the territory (Splendiani et al., 2013). The experiential paths also lead to an enhancement of the identity of places (Sepe, 2013, 2017) and their specificity, able to counteract the homologation of sites with drifts of globalization. Among the Unesco heritage foods, as mentioned before, there are the Neapolitan Pizza, the Mediterranean Diet, the French Cuisine and Belgian Beer, but there are also quality products in Unesco sites that offer different possibilities for an integrated territorial enhancement. Still, sports such as running, Nordic walking and mountain biking are sports that approach places in an ecological way. Some sporting events are linked to Unesco sites such as the Val d'Orcia Tuscany Crossing, the Unesco cities marathon or the North Face Lavaredo Ultra Trail. There are also sports that form part of the tradition of a territory and that must be preserved and enhanced as an integral part of the territory. Useful references are the 2015 International Charter for Physical Education, Physical Activity and Sport and The power of sport values, both by UNESCO (www.unesco.org), which help to understand the interest in sport as an element of enhancement of a territory but also to protect people's health. From this illustration and from the change in tourism demand and supply described in the introductory paragraph it is possible to understand how difficult it is to deduce the relationship between the success of a site as a Unesco site or as part of a specific circuit or a particular way of promoting a territory. In this regard, another element of interest for the investigation

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is to understand the relationship between the Unesco management plans (if adopted) and the urban planning instruments in force in that territory.

A methodology has therefore been developed to collect and relate different types of tangible and intangible data in order to understand virtuous and critical factors for the enhancement of UNESCO assets and the added value offered by the brand.

The methodology consists of:

- surveys of the area in question with photographic relief;
- data collection through bibliography, ad hoc files and internet searches;
- data collection on tourist presences;
- questionnaire to site users and collection of opinions and comments on tourist booking sites and social networks.

To this end, ad hoc database have been created to identify the site's potential, facilities and services. For the potential, we identify in the tab: places which are entirely UNESCO sites (eg: Alberobello); places that have within them a good declared Unesco (eg: the Dolomites); places that already have their own tourist characterization (eg: seaside resort, eg: Porto Venere; skiing, eg: the Dolomites; religious, eg: Pompeii, etc.); places that do not have a characterization but are within a larger territory with their own specificity; places without a specific characterization included in a territory without specific tourist connotations; places that have a broad presence on the Internet, such as to make them known even to an international tourism; Places that are not very present on the Internet; places which are already included in tourist packages (cruise, sector such as ecological, cultural, trekking, health, etc.); places that are venues of cultural or sports periodical events; places that are known for quality food and wine products; current urban planning tools.

With regard to equipment and services, the following are identified: level of accessibility of the site; presence of dedicated public spaces or of public spaces built around Unesco goods; presence of dedicated Unesco signage; provision of specific apps indicating the Unesco site and/or virtual reconstructions (especially for archaeological sites); presence of specific pedestrian and/or cycle paths to be able to use the site; provision of typical or dedicated transport; level of maintenance of the area surrounding the site; presence of scenarios used for film sets, advertising or similar. There is also a space in the database devotes to annotations to be made on observations and other things not provided for before the inspection, but considered useful for research purposes. In addition, a questionnaire was added to these data aimed at understanding the perception of users of the site with respect to it. The questionnaire includes the following questions, which can then be modified with respect to the specificities of the site in question.

1) How did you known this place?
2) Is the first time that you visit this site?
3) What elements strike you most (persons, things, etc…)?
4) Is there one or more elements which produce a particular sensation?
5) What kind of activities do you prefer to practice here?
6) Do you use an app, virtual guide, or something else as a support to your visit place?
7) Is for you preserved the place identity?
8) Do you know that this is Unesco Heritage?
9) Is there something which bother you?
10) If you could change, improve, or enhance anything, what would you do?
11) Is this place comparable to another part of this area or elsewhere? If so, why?
12) What is the symbol of this site? What is the symbol of the area?

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3 THE CASE STUDY

The research, still in development, is analyzing several Italian UNESCO sites and deepening those considered most emblematic from different points of view. The list of sites analysed includes: *Rome – the historical city; Florence – the historical centre; Matera – i sassi; Napoli – the historical centre; Siena – the historical centre; Alberobello – i trulli; Amalfi – la costiera amalfitana; Pompei, Ercolano e Torre Annunziata – le aree archeologiche; Caserta – la Reggia, il parco, San Leucio e l'acquedotto vanvitelliano; Cilento – il Parco Nazionale e il Vallo di Diano, Paestum, Velia e la Certosa di Padula; Tivoli – villa adriana; Tivoli – villa d'este; Genoa – the new roads and the system of the palaces of the rolls; the Dolomites*.

From a first survey of the data collected, the asset that results to be, from the point of view of enhancement in terms of the use of the Unesco brand, one of the best practices, also assisted by a wide use of apps, web portals, social networks, are the Dolomites.

The Dolomites extend for over 140 thousand hectares with a further buffer area of almost 90 thousand hectares between the provinces of Belluno, Bolzano, Trento, Udine and Pordenone and include nine systems: Pelmo, Croda da Lago; Marmolada; Pale di San Martino, San Lucano, Dolomiti Bellunesi, Vette Feltrine; Dolomiti Friulane and Oltre Piave; Dolomiti settentrionali; Puez-Odle; Sciliar-Catinaccio, Latemar; Bletterbach; Dolomiti di Brenta (Hall, 2006; Martini & Buffa, 2016; Menardi, 2017; Sepe, 2015; Sigala, 2018; Yang & Lin, 2011). The studies and visits for this case were carried out over three years, during which time data were collected and questionnaires carried out. A summary of the results is provided below. With regard to the potential information sheet, the Dolomites are located in different locations that: have mainly tourist features (sports, ecological, food and wine, etc.) and have a large presence on the Internet, such as to make them known to the international tourism. The Dolomites are included in tourist packages for trekking, health paths, etc. and are located in areas that host regular cultural and sporting events. With regard to UNESCO in particular, the Dolomites UNESCO Fest will be held from 9 to 16 June 2018: these represents the feast of the Dolomites World Heritage Site. Many of these places are known for quality food and wine products, from wine to cheese and cold cuts (speck in particular). With regard to the urban planning tools in force: each municipality in which they are located has its own urban planning tool; there is no single management plan, but there is a Comprehensive Management Strategy (www.dolomitiunesco.info) that "places the natural environment at the center of social and economic interest and cooperation is the method for experimenting with innovative policies for conscious growth, which implement the concept of natural heritage as a living environment. It is a concerted document that represents the will to overcome the passive conservation of the environment in favor of a widespread environmental responsibility (Protected Landscape Approach). The Strategy is therefore a flexible and dynamic instrument, a set of strategies and objectives that can be adapted to the places and verified over time, on the basis of a process that includes mediation and compensation between different interests". This Strategy followed the participatory action called #Dolomiti2040, aimed at involving in the coordination the multitude of subjects working in the vast and fragmented UNESCO Dolomites Serial Site in order to bring out proposals, expectations and hopes. It was adopted by the Board of Directors of the Dolomiti Unesco Foundation on 21 December 2016. A summary of the results of the endowments and services sheet is given below. The level of accessibility of the sites with the Dolomites is good on average. In any case, it should be specified that, since these are mountainous areas, the level of accessibility is mainly referred to villages and flat routes. As for the presence of public spaces dedicated to or built around them, there are many walks that, in addition to allowing observation during the walk or sports activities, are equipped with "balconies" to allow a stop with a view of

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the Dolomites. During the inspections, no spaces created specifically for this purpose were observed, but rather existing spaces that were better exploited. With regard to signage, a good presence of the Unesco symbol together with that of the Dolomites along motorways, pedestrian routes and cycle paths were noted. Furthermore, there are many apps with Dolomites Unesco site information, several of which have functions related to walks and sports (Dolomites Passport, Drei Zinnen Dolomites, Dolomiti super summer, Dolomiti superski, etc.). As for the presence of specific pedestrian and/or cycle paths to enjoy the Dolomites, these are different, all very well marked and object of tourism promotion: from the walk through the Three Peaks of Lavaredo, to those of the Fiscalina Valley, from the Miglio di Sesto to the Maite Spring, each with its own shelters and the possibility of doing activities of different kinds. With regard to the provision of typical or dedicated transport, in many countries there is transport by sleighs and horses in winter and typical trains. There is also the Ski Pustertal Express that serves all the villages of Val Pusteria, as well as a bus service that serves all the towns of Trentino Alto Adige. With regard to the level of maintenance, the survey focused mainly on pedestrian and cycle paths, which are generally in good condition. As these are mountain areas, maintenance is also dependent on the climatic conditions of the period in which the survey is carried out. Finally, regarding the use of the Dolomite landscapes for film sets, advertising and television series, among the television series there is "A step from the sky"; among the films, The pink panther, Abel - the son of the wind", "The Bear Skin"; among the advertisements there are many for chocolate, yogurt, speck, cars; among the music videos, there is that of Cold Play, Up&Up and others. Also worth mentioning is the Messner-mountain-museum designed by mountaineer Messner, a museum circuit consisting of six locations, each dedicated to a specific theme. That on Monte Rite is dedicated to the Dolomites; that on Plan de Corones is home to several film sets. As regards tourist presences, the trend is increasing both for what concerns Italian and international tourism, even if the mountains remain the third motivation in percentage among the choices of visitors in general. The first motivation that absorbs about 60% half of tourism is cultural, followed by bathing, which absorbs 20%. The mountain is at 10%. The increase that is being recorded is due to a diversification of the offer that is open to different types of sports and activities, which have led to differentiate the periodicity, to tourism for health and wellness, (which in itself is valid throughout the year) and the creation of websites and web portals, apps, social networks to support. All is supported by a wide activity of tourist promotion that Trentino Alto Adige has been skillfully carrying out for many years, using in a suitable way the Unesco recognition (www.enit.it/it/studi.html; www.istat.it). As for the questionnaire, it was placed in particular in the Dolomites of the provinces of Bolzano and Trento in Trentino Alto Adige. The questions were asked to about 200 people aged between 20 and 70 local and tourists (mainly from Italy, Austria, France, Spain, England, Germany, and, to a lesser extent, from Brazil and the United States) over a period of three years and the answers, although not always similar, offer a fairly homogeneous picture of the perception of people with respect to the Dolomites. Online ratings were collected on sites such as Booking, Tripadvisor, Facebook, twitter and instagram.

1) How did you known this place?

The majority of people answered that they had known the Dolomites from a very young age. A smaller percentage, particularly foreigners aged between 20 and 30 years, answered that they knew the Dolomites from a search on Internet holiday sites and on Instagram.

2) Is the first time that you visit this site?

Italian and Austrian tourists have replied that they visit these places periodically. European tourists replied that it was not the first time, while those overseas mainly replied that it was the first time.

3) What elements strike you most (persons, things, etc.)?

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This question has been answered in different ways. 60% of the interviewees, regardless of age and origin, responded to purely naturalistic aspects such as the beauty of the mountains, summer and winter landscapes, the smells of nature and the colours of the mountains. 25% responded by small towns, local architecture and food. The remaining 15% responded with a good logistical organization for tourism (good connections, good accommodation facilities, good reception).

4) Is there one or more elements which produces a particular sensation?

To this question the majority of the interviewees answered the contact with nature expressed in different forms, from landscape observation to sport activity.

5) What kind of activities do you prefer to practice here?

The 70% of the interviewees answered that they prefer to do sport activities of various kinds (skiing, climbing, paragliding, mountain biking, running and trail running, etc.) or walks in the paths, often related to visits to shelters. 30% responded by resting, going to wellness centres, eating and drinking quality local products.

6) Do you use an app, virtual guide, or something else as a support to your visit place?

The 90% of the interviewed tourists answered that they use virtual products of various kinds before, during and after the visit. Among the apps they have named Dolomites Passport, Drei Zinnen Dolomites, Dolomiti super summer; among the websites https://www.dolomitiunesco.it, https://www.dolomiti.it; among the social ones: instagram and facebook. These are joined by sites for booking transport and accommodation facilities.

7) Is for you preserved the place identity?

This question is complex and has often been combined with another question, such as: is the uniqueness and specificity of the place preserved here?

All the people interviewed said yes, adding that their visit is also due to the fact that they know they are finding a place whose specificity remains over time.

8) Do you know that this is Unesco Heritage?

The 60% of the interviewees (mainly Italians and Europeans in general) replied that they were already aware of it before the visit. 40% of them replied that they had learned about it during the visit.

9) Is there something that bother you?

Respondents replied that they were not bothered by anything. Only few people responded that they were bothered by vehicular traffic during periods of high tourism presence.

10) If you could change, improve, or enhance anything, what would you do?

The 80% of the respondents replied that they would not change anything. Around 10% said that it could be improved the supply of cultural events. The remaining 10% responded that more squares and seating spaces should be created in the countries.

11) Is this area comparable to another area of here or elsewhere? If so, why?

The most frequent answer was that the Dolomites are comparable to other mountains, but they are unique in themselves. Regarding the locations in which they are included, most of the interviewees have compared the villages to other similar villages in Trentino Alto Adige.

12) What is the symbol of this site? What is the symbol of the area?

The 60% responded the three peaks of Lavaredo, the remaining 40% gave different answers such as Braies Lake, The Dobbiaco Lake, the Dolomites in general, the Sassolungo Lake, Garda, the Tyrolean style houses.

With regard to comments, judgements, images and related "likes", they reveal tangible and intangible aspects of the Dolomite places. From the ratings on the booking sites hotel, in particular Tripadvisor and

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Booking general ratings, these are very positive and related to: the emotions that can arouse about the landscapes defined as often spectacular, unique, beautiful; food; sport and leisure activities related to nature to be carried out. All these factors ensure that tourism is experiential, aimed at raising awareness of the territory and its culture in all its aspects and to involve the visitor totally. Some people observe a lack of activities for the evening in small localities. Many places where the Dolomites are located are defined as particularly suitable for families. Membership of Unesco is not mentioned in the judgements. With regard to social networks, from a first analysis carried out on Facebook, Twitter and Instagram, it is possible to draw these data: there are currently about 100 hastags with the name composed with dolomites on instagram and cited on twitter, of which #dolomitiunescoworlderitage has 555 posts, #dolomitiunesco 26.754 posts, #dolomitipatrimoniounesco 1,361 posts; the profile instagram dolomites has 56.8 thousand followers, dolomitisuperski has 54.6 thousand followers, while trekkingdolomiti 2.806 followers; the hastags on twitter about the dolomites mainly concern photos of mountain landscapes in different seasons with comments on the extraordinary beauty of the places; on facebook: dolomites unesco is followed by 28,353 people, dolomitesunescoworldnaturalheritage is followed by 1115 people, North Face Lavaredo Ultra Trail is followed by 34,702 people (www.booking.com; www.facebook.com; www.instagram.com; www.tripadvisor.com; www.twitter.com).

4 CONCLUSIONS

The article illustrated the results of the research project "Contemporary urban landscape design: place identity, happiness, liveability, health and sustainability" (with the author's responsibility), in development at IRISS-CNR, concerning Unesco sites. In particular, the article, after illustrating the methodology used for the case studies, highlighted the aspects of innovation and sustainability in the specific case of the Dolomites, which joined the WHL in 2009. There are several aspects of excellence that make the Dolomites an emblematic case of the enhancement of tangible and intangible resources and the appropriate use of the Unesco brand. Many of the places in which the Dolomites are located are destinations for winter tourism linked to skiing. Over the years, the snowy landscape linked to it has been an essential part of the imagination of these places. In addition, skiing is also linked to a very broad economic system that involves many sectors that contribute to the operation of the complex tourist machine linked to it. In the last years, climate change has been changing the landscape of these places. For some years, snow has not fallen or has fallen in periods other than winter, creating many problems from the point of view of the organization of the "sports machine". Artificial snowmaking has become standard practice in some places and the image of these places has changed: the landscape, which was previously completely white in the winter months, has increasingly become half white and half green, leading to a slight decline in ski tourism. On the other hand, it has become necessary to expand supply in response to changes in demand, which is increasingly segmented and, in some ways, demanding. Although at present mountain motivation represents 10% of national and international demand, the ecological, food and wine and sports sectors are growing. The ten-year experience in the field of hospitality and tourist reception of Trentino Alto Adige has meant that, in order to keep the influx of visitors constant throughout the year, the offer was expanded, creating more sporting opportunities related to other disciplines such as climbing, mountain biking, running, the ultra trail, the latter growing rapidly internationally. Many competitive events attract visitors from all over the world throughout the year, creating new opportunities for the promotion of the Dolomites even in periods not strictly tourist. These races are extended on routes of exceptional scenic interest (North Face Lavaredo Ultra Trail, International Lake Caldaro Triathlon, Südtirol drei zinnen alpine run, etc.).

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The help of new technologies is used here and is of considerable support: apps, websites, shooting with drones and other technological tools allow the success of events and the promotion of the territory by expanding the knowledge of these places and the desire to see them, live them, share them, and comment on them. In this respect, some territories have joined together in consortia to create a unique brand, as in the case of the Dreizinnen/Trecime dolomiti brand, which groups together five peaks in Alto Adige. It promotes its territory by underlining its membership in UNESCO and through six values: mountaineering, accessible, feeling comfortable, suitable for families, majestic, better. All these factors ensure that tourism is experiential, aimed at raising awareness of the territory and its culture in all its aspects and to involve the visitor totally. However, a critical situation must be outlined. It is represented by the fact that the Dolomites extend over a very large area located in four provinces. The territories that the Dolomites cover are very different from each other, especially from a cultural and linguistic point of view: the languages spoken are Italian, German, Ladin, as well as about 40 dialects. The municipalities have their own urban planning tools and the programme that manages the Dolomite territory is the Complex Management Strategy which, however, does not act as a planning instrument but as an active protection tool. The lack of an urban planning tool that regulates the whole Dolomite territory means that the development and management choices, although innovative and sustainable, can be defined as successful, above all in terms of promoting tourism and therefore the economy, but - in the long term - these could lead to choices that are not suitable in terms of planning the growth of the territory, accessibility, maintenance of parts of the localities outside the tourist industry, as well as socialization of the population. This is testified, even if to a lesser extent, by the lack of real places of socialization, such as public spaces, or events not for mainly tourist interest in different places. Moreover, the information contained in the sites and web portals are generally disparate, and, while reporting images of unique landscapes and multiple activities in place, often have an overabundance of information, which can confuse the choice of places to visit. It would therefore be necessary, especially in the long term, an overall management plan for the Dolomites that would regulate in a more comprehensive manner the protection and promotion of these territories with a relative adaptation of the urban tools of the municipalities in which they insist. In any case, at present, the set of actions implemented by the Unesco Dolomiti site make it an emblematic and innovative case of enhancement and promotion of the territory. The extraordinary and intact beauty of these sites together with a valid use of Unesco recognition are - among the Italian sites - an example of good practice and will be used to construct the guidelines for sustainable and innovative promotion and fruition of the Unesco sites in Italy, final output of the research.

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TOWARD CLARIFICATION OF MEANINGS VIA ONTOLOGICAL ANALYSIS METHOD

IN ENVIRONMENTAL PLANNING PROCESSES AND ACTIONS

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ABSTRACT

This work shows a research approach aiming at enhancing standard methodologies oriented to interpret places, by using information coming from new forms of place interpretation and description. This proposal is developed by investigating on geographical places as complex spatial environments well suited for the exploitation of different paradigms. The approach is based on ontological analysis. It can be useful to integrate a cognitive stand within the traditional analytical and organizational views of complex spatial environments, in particular aiming to facilitate decision-making processes.
In this context, the argument of the paper has a twofold implication. Certainly, the introduction of ontological layers is rather useful for organizing the modelling of complex systems. Yet, while these layers are informative, our understanding of space cannot be reduced to the ontological elements per se, as they may lack a contextual perspective. Deeper studies and research are then needed to develop formal frameworks that effectively integrate standard and ontological methodologies for general modelling purposes in environmental planning.

KEYWORDS

Spatial Cognition; Ontological Analysis; Cognitive Modeling; Planning

1 INTRODUCTION

Multiple commonsense definitions are possible for places. They are landscapes observed from far distance, as well as cities that are lived from inside or imagined from outside. They can be seen as ecological systems, social-technical systems and much more. This notion variety is harshly challenging for modelers typically based on limited methods and modelling techniques. Yet, models are required to identify and manage a large diversity of information and standpoints. In order to deal with such challenge, the approach of this work is on *lived places*. An underlying notion of physical place is put here, made up of a concept of space and a concept of place. They have different declinations and possible definitions, none of them simple. For example, a cognitive viewpoint considers space as typically developing and changing with agent's changes and evolutions, not just a geometrical entity (Freksa et al., 2014). Possibly more complicated than that, place is an interpreted, reasoned space, raising feelings, resulting from an aesthetic fruition etc. Place usually embeds a set of mental images, also representing an architecture of cognitive processes. Place's essence is connected with the quality of being in a specific location -e.g., "here" and perhaps not "there" (Rapoport, 1977). For example, the status of *being enclosed* (enclosure) tends to be a key aspect of the construction of a place. Places are mainly understood through cognitive contexts. That is why we can read *places in which we live*. We can interpret our being in a space as an objective proposition according to geometrical rules/indications. Nonetheless, our being in a place is defined only via a richer description. Every single person in a place has a subjective point of view and it is that point of view that characterizes that place as such. Points of view and contexts are results coming out from a historical – cognitive – cultural selection. Our knowledge of places can derive from experiences, from stories that structure ideas and feelings about them. When we talk about 'subjective knowledge' of places, what are we really dealing with? 'Subjective knowledge' is a kind of representation of places, and a representation vary from subject to subject and even across one's life (Orr, 1992). "Knowledge of a place — where you are and where you come from — is intertwined with knowledge of who you are. Landscape, in other words, shapes mindscape." (Orr, 1992). Many attempts have been carried out to get a definition of space representation. Ontological research (Borgo & Masolo, 2010) is increasingly seen as providing methodologies and tools to move forward in this direction. One advantage is that these systems are typically specified in languages that abstract away from data structures and implementation strategies. The languages of ontologies are closer to first-order logic than languages used to model databases. In computer and information science, an ontology is a technical term denoting a conceptual artifact that is designed for a purpose, which is to enable the modeling of knowledge about some domain, real or imagined (Gruber, 1993).

2 DEALING WITH PLANNING

The complexity of social and natural environments usually implies a dramatic level of uncertainty in modelling techniques. The traditional deterministic and quantitative approaches to urban planning and design in risky contexts seem to increasingly fall short of expectations in environmental domains; and this is now widely recognized (McConnell et al., 2010). Typical planning approaches try to manage complexity as the result of a recurring interaction between collective knowledge and the desired results. This position requires that *sharing* is the foundation of a necessary political dimension of contemporary design (Formato & Russo, 2014). An urban project as a plan or as a strategy has to evolve over time, it can't stay frozen (Ingallina, 2007). The planner, like the urban designer, has always to look at changes of the territory and

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has to read the different relationship between built space and complex urban organization. Architecture, social sciences or anthropology have an active role in the thinking and the development of urban projects. In the anticipation game, a city is a relational system that must be thought as a whole, not a mere composition of districts (Gregotti, 2004). For these reasons a rich and reliable modeling of the place is an essential starting point for the planner.

3 INTERPRETATIONS OF GEOGRAPHICAL PLACES

Complex spatial environments are lived, moved and perceived by humans using different paradigms. Their interaction with space is sophisticated. It continuously changes over time and relies on a variety of information types that can be classified in as many types as topology, geometry perspective, dynamics, affordance, society, culture and so on. Perhaps due to the richness of this interaction, humans are not aware of how their understanding of and interacting with space is realized. Ontological analysis, the study of what is at the core of our view on reality, can help to recognize, clarify and organize the essential elements and features of places that is crucial to humans in terms of objects, properties and processes. Searching for a general framework where to discover and organize this kind of information, we can list a few layers that seem quite relevant. Without aiming at an exhaustive list, we propose to subdivide these layers as follows: spatial, artifactual, cognitive, social, cultural and processual. These layers, in turn, can be subdivided in finer layers as we can see from these cases.

<u>The spatial layer</u>

The spatial layer may be considered as perhaps the most studied layer since it is in large part independent of the subjective perspective easily leading to a formal analysis (Bateman et al., 2007). Here we can recognize the *mereological* layer within which one understands space in terms of parts, e.g., recognizing the distinction between an area and its neighborhood. A second layer is the *topological* one within which one understands space in terms of contact and unity, e.g., recognizing the contiguity between neighborhoods and the unity of a city. Another layer is the *geometrical* where one understands space in terms of shapes, e.g., recognizing that the shape of a city is constrained by that of the valley where it is located. Finally, the *geographical* layer in which one understands space in terms of locations and their descriptions, e.g., distinguishing being along a valley or having a radial disposition in space.

<u>The artifactual layer</u>

Within the artifactual layer one recognizes the physical realm and how human activities can change it. Here we have the *material* layer where one understands space in terms of materiality, e.g., seeing the presence of wood, concrete, water. Then the *structural* layer that allows to understand space in terms of qualified components, e.g., distinguishing natural vs manmade and a residential are vs a production area. The *artifactual* layer adds an intentional aspect to the environment (Borgo et al., 2011), e.g., looking at a garden as an intentionally modified environment. The next layer is the *functional* one where one understands space in terms of functionality, e.g., recognizing a building as a shelter. Finally, the *production* layer looks at entities as manipulation sites, e.g., seeing a farm as production site.

<u>The cognitive layer</u>

The specific abilities of humans play the main role on the cognitive layer. The basic *cognitive* layer allows to understand space in terms of experience, e.g., perceiving how to move across objects in space. Instead, the *representation* layer leads to understand space in abstract terms, e.g., perceiving the relationships among areas in an airport. The *observation* layer is where one understands space in terms of how things in it may change, e.g., perceiving the change in the transportation system. Next, we have the *phenomenological* layer

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where one understands space as a moving entity, e.g. perceiving a city as evolving. The *perspectival* layer allows to understand space from a perspectival viewpoint, e.g., differentiating a square depending from where one is looking at it. At the *conceptual* layer space is seen as a collection of realized concepts, e.g., perceiving space as the manifestation of natural and artificial objects. Finally, the *action* layer where one understands space as an entity in which to act, e.g. perceiving the changes that one can enforce on things.

4 A CASE-BASED APPROACH

The experimental context of the present work of ontological analysis of places is the making of Taranto (Italy) strategic plan, oriented to 2065. Data were collected via a series of nine community-based, interactive processes of knowledge exchange, aimed at building future scenarios for the new plan. The interactive processes of knowledge exchange were carried out in Taranto, southern Italy during spring and summer in 2014. They were carried out to support policies and decisions on urban socioeconomic as well as environmental domains and organized as a sequence of face-to-face brainstorming forums aimed at cooperatively singling out strategic lines to build alternative development scenarios. From a methodological point of view, it was a 2-step *scenario-building* activity (Khakee et al., 2002). First, agents were invited to report problems they faced in their town districts. Then, each agent was invited to generate a reflection about the future of the district, particularly concerning expectations of future changes. Such sessions were organized in all town districts, indoor or outdoor, with participants divided in groups each of them sitting around a dedicated desk. A municipal representative coordinated each desk without taking part in the generative session, she/he had only the task of transcribing in linear charts concerns, problems, expectations and desires presented by the participants at the desk.

Fig. 1 The Taranto case study

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Real time synthesis and refinement of results during the interactive process was supported by the use of conceptual maps drawn using dedicated software tools (Decision explorer, Inspiration) (Heft, 2013) (Fig. 2). This resulted in a real/virtual hybridization of the process, following well-established research trends, as reported in a number of case studies (Khakee et al., 2002). During the nine interactive meetings, a number of results were achieved, being very different from one another. In particular, the first meeting was organized in the Città Vecchia (inner city district) with its great historical, environmental and cultural resources as well as significant environmental, physical and social degradation problems. In the Città Vecchia session the citizen participation was very high. About 80 stakeholders joined form different societal domains: residents, merchants, students, tourists, visitors. These agents, gathered around 6 desks, interacted intensively, so that about 150 instances were collected in the end. The resulted database of session was very rich, interesting and articulated. Because of this reason, it represents a significant and valuable source for the present research effort.

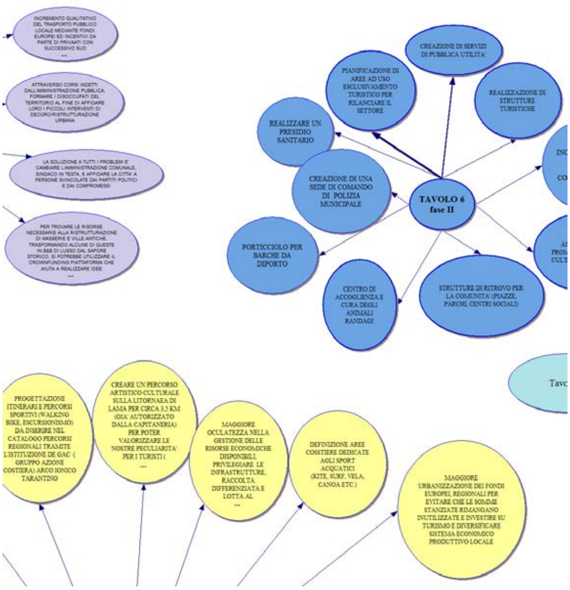

Fig. 2 Example of *cognitive map* (excerpt)

In a fairly natural way, the process leads to two general types of instances, that is, contextual problems and future visions. These two set of instances are about each quarter of the city as well as about the city in general. From an analysis of the data emerges that the environment is the most recurring issue in the groups. It is present in community problems and/or expectations, but also in the perceptions of the physical reality of the city. The industrial problem, on the contrary, is often absent from the discussed issues. Looking across the groups, a first common character is the natural environment, present and persisting in many city representations - so apparently resisting the consequences of an industrial culture. A second one is related to a structural relationship that the city has with the sea, intended as an element of both union and communication. A third is the potential of the city as tourist attraction which is linked to different characters in relation to the different peculiarities of the area. The industrial problem often seems

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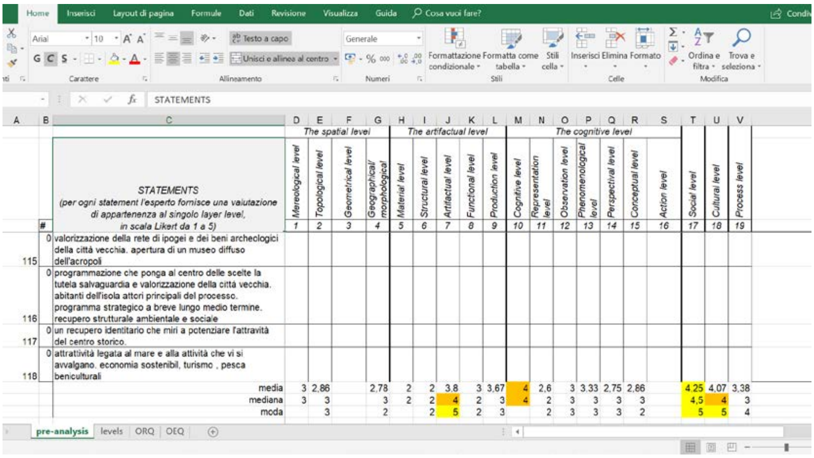
idiosyncratically absent from protocols, but it is difficult that findings can be used for strategies disregarding industrial relations. The forum session held in the industrial district showed an almost total absence of participants, perhaps given the disillusionment with past policymaking. Other issues are related to the inadequacy of urban and metropolitan linkages to the city center, as well as related to the recovery of many illegal settlements. Other instances are about the inadequacy of the urban services and about the inadequacy of metropolitan connections. Further instances are about the recovery of unauthorized coastal settlements. The Città Vecchia (inner city) forum session was quite a complex event and process. It was held with a hybrid computer-based and traditional, rather conflictual interaction among the participants. Outcomes showed a clear prevalence of visions on mere problems: important issues were the unstopped relationship with the sea (for touristic aims and/or city infrastracturing) and the enhancement of Taranto as archaeological and historical center (Magna Graecia colonization).

5 ANALYZING THE SOCIAL LAYER

Generally speaking, the analysis of layers is useful to identify if every layer is well structured or if it is necessary to model additional information. Later in this research line we will proceed to characterize the specific sub-layer. Taranto dataset was built without specific research objectives since it was collected during the participation activities belonging to the strategy planning process. However, we think that it can be useful to start from this data for a first delineation of 'objects', 'attributes' and 'relations' populating the different layers.



	#	STATEMENTS (per ogni statement l'esperto fornisce una valutazione di appartenenza al singolo layer level, in scala Likert da 1 a 5)	Mereological level	Topological level	Geometrical level	Geographical/ morphological	Material level	Structural level	Artifactual level	Functional level	Production level	Cognitive level	Representation level	Observation level	Phenomenological level	Perspectival level	Conceptual level	Action level	Social level	Cultural level	Process level
			The spatial level				The artifactual level					The cognitive level									
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
115	0	valorizzazione della rete di ipogei e dei beni archeologici della città vecchia. apertura di un museo diffuso dell'acropoli																			
116	0	programmazione che ponga al centro delle scelte la tutela salvaguardia e valorizzazione della città vecchia. abitanti dell'isola attori principali del processo. programma strategico a breve lungo medio termine. recupero strutturale ambientale e sociale																			
117	0	un recupero identitario che miri a potenziare l'attravità del centro storico.																			
118	0	attrattività legata al mare e alla attività che vi si avvalgano. economia sostenibil, turismo , pesca benicuIturali																			
		media	3	2,86		2,78	2	2	3,8	3	3,67	4	2,6	3	3,33	2,75	2,86		4,25	4,07	3,38
		mediana	3	3		3	2	2	4	2	3	4	2	3	3	3	3		4,5	4	3
		moda		3		2		2	5	2	3		2	3	3	3	2		5	5	4

Fig. 3 An evaluation of the possible ontological levels of analysis

A pre-analysis was carried out aiming at trying to work out the most significant layer on which to carry out our ontological analysis. All statements were broadly valued by the authors on a simple 1-5 scale for their semantic closeness to each layer. After concisely looking at statistical descriptors (Fig. 3) we decided to start from the social ontological layer. Above all, the material collected in the Taranto case study is very rich from this perspective. We also believe that the material could be useful to analyze the cultural and process layers but this has not been evaluated yet. These views are not studied in this paper. Finally, the material collected in Taranto does not seem suitable for an analysis of the remaining layers, e.g., cognitive and spatial.

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In order to specify the context of this analysis, we need to limit the broad connotation of 'social' to a main focus on social practices, i.e., the way people live a city and its parts. Still, we include also the quality of the interactions between people and how they change in time. Note also that at the social layer it can be difficult to elicit the distinction between formal and informal knowledge because the social knowledge is principally informal, tacit and implicit. For this reason, our work in this paper should be considered preliminary under several aspects. References to places and landmarks are singled out their relevance in social practices and by listing the relevant entities and the relationships that were expressed between them. Then we look at how inhabitants use those places and the social habits they implicitly or explicitly expressed. Finally, we classify the collected entities in ontological terms following the DOLCE foundational ontology (Borgo & Masolo, 2010). By carrying out our analyzing effort, the social layer it clearly emerges that the objects of the city are not just building, locations and landmarks. They are complex cognitive objects enriched with a set of different meanings/signifiers that can acquire different meanings depending on the time and even on the person. This analysis shows that at some point it will be necessary to investigate complex entities' definitions. Also, several objects that a technician would image essential key points for the sociality were not mentioned in the discussions, for instance: the San Cataldo cathedral, the S. Domenico church, the Ringhiera, the doric columns, the Aragonese castle, Fontana square, the stone bridge, the Ponte girevole and even the town hall. Instead we find *places* and *landmarks* like the beachfront, the bathing establishments, the area of Porta Napoli, the new Acropolis, the island and the piers. These entities are separated from other *objects* which are taken at their face value like buildings of low interest, the cruise ships and, from some aspects, the sea itself. Indeed, the same term can occur with different meanings, e.g., as a landmark and as a generic building. These lists do not cover the whole range. Many entities have special social *roles* like the city itself as the capital of Magna Grecia, the convergence point (a place where roads and railways converge), the service center or the old city seen as an eco-museum. At this point, we have the *service* layer that includes public services like restaurants, cafes and shops, bathing establishments (this time the term denote the service, not the physical entity nor the landmark), the service center, the university and the pedestrian network across the city (mainly identified in special areas like the waterfront). Finally, the identified the desired features which can be presented as functional objects, reassessment of existing objects, services, norms or generic topics. Here we find work, areas close to traffic, primary and secondary infrastructure, regulation of public spaces. When considering relational aspects, we need to point out the difficulties to classify the above elements since the data are only partially qualified for our analysis. This leads to some uncertainty regarding the relationships holding across these elements. We find strong relational bounds between the space and the city in terms of districts, between space and objects in terms of locations, space and landmark or role, space and services (the location of needs), landmark and social practices as well as between social practices.

4 CONCLUSIONS

Perspectival considerations usually strongly characterize the way we live in places. It is a kind of description (mostly implicit) of the place that includes what are for us the relevant elements in it and their relationships. Thus, a perspective provided by a place is an information entity that contains: a (typically partial) description of the place, what there is in it and how the place is evolving (e.g. things moving, leaving or arriving, agents acting and transforming them etc.) and possibly the potential interactions between us and what is in the place. A place is grounded, as opposed to a generic location, is a context that refers to one or more actual/existing entities.

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A number of links usually enrich a place, suitable to be elicited by ontological analysis and classified for understanding places in general and the actual place that we are experiencing. For this reason, the analysis has to include the physical elements (e.g. location and objects), the material components and layout (e.g. enclosed spaces, object distribution); agentive figures (e.g. habitants, organizations, social roles) the relationships across them and the objects (e.g. generic dependences and actual goal or habits). In the end, a concise ontologic taxonomy has been drawn out, whose excerpt is reported in Fig. 4.

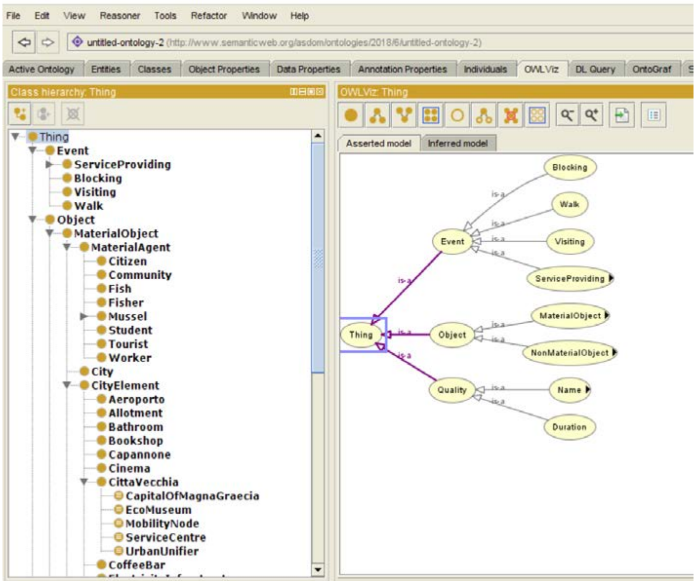

Fig. 4 Protege layout (draft)

We decided to start from the highest layer in the given ontological list, i.e., the social layer, because of the available database at hand. Here we have reported the very first achievement of a complex ontological analysis aimed to unravel the complex knowledge that forms the city. The following activities of our research is being increasingly devoted to this aim.

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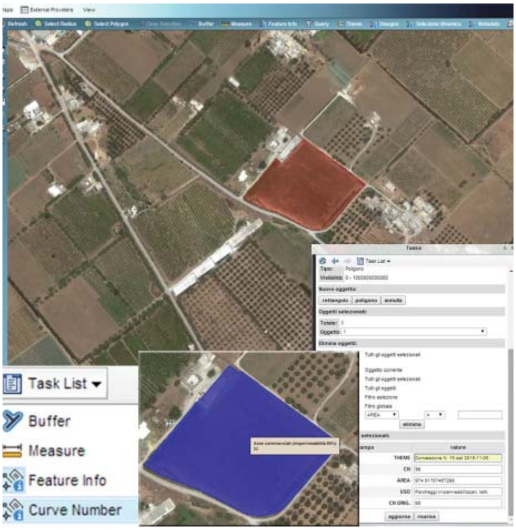

IMPLEMENTING GIS TECHNOLOGY

A SPATIAL DECISION SUPPORT SYSTEM TOOL TO STUDY THE IMPACTS OF LAND USES

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ABSTRACT

The need of soil consumption control and of the conservation of eco-systemic values of existing resources are the basis of this attempt to implement the GIS technology as a web-based Decision Support System. Following the European Community guidelines, an instrument for limiting, mitigating and compensating soil sealing is set in place, ensuring that the hydrological response of a given area during precipitation must remain constant before and after transformation. It is presented a practical approach with a technological improvement through a GIS evolution in the field of anthropic impact analysis. The web application makes use of the SCS-CN Soil Conservation Service-Curve Number method developed by the USDA in 1972 to study the phenomenon of the run-off. The web application, built as a webGIS service, based on the online interoperability of multiple users, defines a tool for the control of man-made impact and for a BMP-Best Management Practice driven policy for boosting eco-systemic values in Regional Planning. The challenge is to bring together GIS tools and evaluation models in a networked environment by implementing them towards online interoperability. Public officials, in charge of evaluating new projects, can be guided by the tool in the ex ante and ex post simulation of the land transformation. The effects that the land transformation causes are reflected in the CN as shown trough the web application therefore BMP to improve the hydrological solicitation response can be promoted. The tool is able to help the decision-making actors to cope with the complexity of reality and can help the planner towards strategic decisions based on spatial data.

KEYWORDS

Spatial Decision Support Systems; Curve Number; Best Management Practice; Web GIS; Land Use Changes

1 INTRODUCTION

In September 2015 n.17 Sustainable Development Goals (SDGs) were adopted by world leaders whose countries will mobilize efforts to end all forms of poverty, fight inequalities and tackle climate change over the next fifteen years. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and addresses a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection.

Environmental threats are experienced mainly in agricultural, natural and semi-natural areas where there is more economic potential associated with a land use transformation. The increase of artificial covering, at the expense of these areas, causes a deep biophysics soil alteration (ISPRA, 2016) virtually irreversible. The main impacts that soil sealing produces, according to the European Commission (2012), are:

- on water resources;
- on biodiversity of underground and surface soil;
- on food safety;
- on the carbon cycle;
- on the reduction in evapotranspiration;
- on air quality;
- on the link between chemical and biological cycles;
- on the quality of life worsening.

One of the major source of degradation of rivers and lakes is the phenomenon of the flow of surface water (run-off). The effective control and management of the flow of water is therefore an evident need and the conservation of soil as non-renewable resource push towards finding solutions to strategic planning for future scenarios of management and regeneration. The removal of the agricultural or natural land associated with urbanization alters the hydrological system with increase in volumes and surface runoff peaks resulting in the release and transport of pollutants in the area in addition to erosion phenomena shortly afterwards.

2 STATE OF THE ART

The Sustainable Development, introduced for the first time by the World Commission on Environment and Development – WCED in 1987 in the Brundtland Report (Our Common Future), is meant as the process aimed at achieving environmental, economic, social and institutional improvements. The process of sustainable development, in line with EU laws, connects the protection and enhancement of natural resources with the economic, social and institutional promotion, in order to meet the needs of current generations without compromising the ability of future generations to meet their own.

These objectives are linked in an interdependent relationship and are opposed to the heritage and natural resources, specially water and soil, deterioration. The consequences of the land artificialisation process are the significant loss of ecosystem services and the increase in "hidden costs" defined by the European Union (European Union, 2013), due to the increasing soil sealing. Ecosystem services are defined as all the benefits that are obtained, directly or indirectly, by ecosystems (Romano et al., 2015). In recent years a decisive signal to environmental sustainability is represented by the European Union Directives which transpose the requirements to counter the degradation of aquatic and terrestrial ecosystems. The degradation of aquatic and terrestrial ecosystems is associated with risks on human health, decreased quality of life and the loss of

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human lives and economic losses caused by disasters (Romano et al., 2015). The CICES Common International Classification of Ecosystem Services classification (Haines-Young & Potschin, 2013; ISPRA, 2016), in Table 1, divides ecosystem services in the following categories:

- provisioning (food and biomass, raw materials, etc.);
- regulation & maintenance (climate regulation, carbon capture and storage, erosion control and nutrient, water quality control, protection and mitigation of extreme hydrological events, genetic reserves, conservation of biodiversity, etc.);
- cultural (recreational, cultural and spiritual functions, landscape, natural heritage, etc.).

Section	Division
Provisioning	Nutrition
	Materials
	Energy
Regulation & Maintenance	Mediation of waste, toxics and other nuisances
	Mediation of flows
	Maintenance of physical, chemical, biological conditions
Cultural	Physical and intellectual interactions with ecosystems and land/seascapes
	Spiritual, symbolic and other interactions with ecosystems and land-/seascapes

Tab. 1 The CICES Common International Classification of Ecosystem Services classification (Haines-Young & Potschin, 2013)

In relation to ecosystem services capability of mediation of flows, the new settlement developments should be designed to minimize impacts on the quality and quantity of water that can possibly cause flooding downstream. The authorization control process of new interventions becomes a way to push the designer to define, on the basis of the outflow assessments, the BMP required size to meet the necessary reduction of the impacts that the proposed intervention could cause. According to Pistocchi (2001) only on the correct representation and prediction of natural resources and their processes can derive practices and environmental policies rational foundation. ICT - Information and Communications Technology tools can be effectively adapted to the requirements of the environmental assessment. One of the ICT tools globally used for territorial analysis is the Geographic Information System (GIS) Technology which was born in the United States around 1960.

The GIS abilities to inform about location, characteristics, trends of the studied phenomena are increasingly been recognized. The GIS Technology is configured as a decision support tool, Decision Support System (DSS), for spatial analysis and for human impacts assessment, as it facilitates proper operational decision based on a correct interpretation of reality. The Geographic Information System as DSS allows:

- a shared geodatabase provision;
- a common cartographic base endowment;
- information dissemination between different entities;
- real time data dissemination;
- information continuous updating tools;
- phenomena analysis tools;
- different levels and sectors training;
- procedures potential optimization;
- resources optimization.

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The resulting challenge is to bring together GIS tools and assessment models in a network environment implementing them to the online interoperability as described by the OSGeo Consortium. The OSGeo Consortium refers to the term interoperability as the ability to find what you need, to access it, understand and use it for own needs.

3 OBJECTIVES

The general framework of objectives of this research work can be identified in:

- the protection of the quality and quantity of water resources;
- the contrast to the uncontrolled sprawl;
- the promotion of Best Management Practices (BMP);
- the sensibilization towards efficiency control in the preparation of building permits at the local level;
- the support to new approaches to integrated and sustainable design.

It is shown a methodology developed for the implementation of support tools for planning and for evaluating impacts on water and soil resources in marginal areas. The underlying objective of the research is to study a methodology for the application of modeling assessment of human impacts on nature on Decision Support System tools and in particular on the GIS Geographic Information System technology. The interest is for the design of a web based DSS for the mitigation of hydraulic impacts on the landscape and for the eco-systemic functions maintenance. This methodology allows to recover a tool, user-friendly and accessible to novice users, to control the impact of new design contributing to the assessment of soil erosion scenarios based on land use change projections.

The resulting effect is, during the validation phase of the project and therefore during the construction permits procedure, an indication of design requirements. In consideration of the surfaces affected by the project it will be necessary, therefore, to perform the mandatory BMP estimation to reduce the transformation impact.

The European Union in the Guidelines on best practice to limit, mitigate or compensate soil sealing (2012) aims to promote three types of approaches designed to:

- limit soil sealing;
- mitigate the negative effects caused by the use transformation soil;
- compensate any inadequacy of mitigation measures.

where the waterproofing limitation of the soil, and then the respect of the hydraulic invariance - according to which, in other words, the flow rate at the peak resulting from an area drainage must remain constant before and after the transformation of the use of the soil in that area - remains a priority compared to mitigation or compensation measures. The European Union (2012), in particular, aims to promote an approach to prevent the conversion of green areas and the subsequent sealing of their surface layer or part of it. This approach in fact encourages the re-use activities of already built-up areas such as brownfields.

It is emphasized, moreover, the use of tools, such as the one proposed, able to support the uncontrolled sealing contrast activity. Mitigation measures are intended to be adopted, where there has been a waterproofing transformation, to keep some of the soil functions and to reduce the significant direct or indirect negative effects on the environment and human welfare.

Among these measures it is placed the use of suitable permeable materials instead of cement or asphalt and an increasingly greater use of natural systems to collect water taking into account however that it is impossible to completely compensate sealing effects.

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4 MATERIALS AND METHODS

In the water sector the numerical modeling is now the basis for all analysis, planning and land management activities. The growing availability of spatial data, observations and calculation tools, enriched by the support of GIS technology allows to conduct more detailed and reliable simulations.
The use of mathematical models that simulate ecological processes is dependent on the availability of a model that adequately represents the case or of a model that is developed ad hoc. The model development, the model implementation in case studies, and the results interpretation are specialized skills whose effect can be applied to the reality influencing the decision-making process. The Intergovernmental Scientific Program Man and the Biosphere Program (MAB) launched by UNESCO in 1971 was promoted to establish a scientific basis for the improvement of relations between people and their environments emphasizing the need to assist policymakers in understanding the interdependence between urban systems and the environment. Rapid urbanization in order to meet urban needs often occurs with the loss of ecosystems and valuable territories (Shen et al., 2011). For the Italian National Institute for Environmental Protection and Research - ISPRA (2016) specific information should be given to local managers to define and implement measures in order to limit, mitigate or compensate soil sealing behaving undisputed advantages for the natural heritage and at the same time for public spending. Last ISPRA's Report on soil consumption (2016) considers it necessary and urgent to provide municipalities with clear information and useful tools for reviewing even the predictions of new buildings inside the urban and regional plans already approved. The Report confirms that the soil is vital for our environment, our health and our economy itself recognizing the value of natural capital. The modeling of hydrological-hydraulic phenomena triggered by precipitation on a basin and, therefore, the formation of full outflows in peri-urban areas, requires the detailed knowledge of the spatial and temporal distribution of rainfall (Fig. 1).

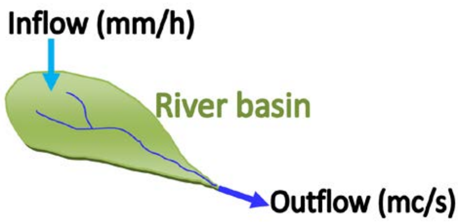

Fig. 1 Schematic representation of surface runoff formation

The volume of water that reaches the closing section as a result of precipitation can be decomposed into four contributions (Greppi, 1999; Moisello 1999):

- direct flow;
- runoff;
- hypodermic flow;
- underground (or deep) flow.

The surface runoff formation phenomena plays a fundamental role in the genesis of flood picks and erosive processes that occur in the catchment areas. The runoff, in fact, is the fastest component of the outflow and it has the flow rate maximum values, this phenomena study is therefore of particular importance in the planning and design activities to safeguard natural resources.

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In the field of general simulation of the phenomena, to be used to guide the design, simple mathematical models are able to represent the global behavior of the basin by estimating the flow rate at the peak.
The SCS-CN method, developed by the Department of Agriculture of the United States of America USDA, the Soil Conservation Service (Soil Conservation Service) in 1972, of the CN Curve Number, estimates the cumulative net precipitation (mm) as a function of cumulative gross antecedent precipitation, coverage and use of the soil and of the initial conditions of soil moisture.
According to the United States Department of Agriculture (USDA, 1986), there are various factors taken into account in determining the runoff CN. The main factors that determine the CN are the hydrologic soil group (hydrologic soil group HSG), the type of coverage, the treatment, the hydrological condition, and the runoff antecedent condition (ARC). Another factor considered is whether the impervious areas discharge directly into the drainage system (connected) or if the flow extends over the permeable areas before entering the system (not connected).
The basic relationship of the CN Curve Number method is as follows:

$$\mathrm{Q(t)} = \frac{[P(t)-I]^2}{[P(t)-I+S]} \tag{1}$$

Where:
Q (t) [mm]: net rain height up to the instant t
P (t) [mm]: Rain height precipitated up to the instant t
S [mm]: maximum storable water height in saturated soil
I [mm]: purification or initial loss = 0.2 * S

This relationship is only valid for P (t) greater than or equal to I, while in the case in which the total height of cumulative precipitation has been less than I, Q (t) = 0 and therefore the outflow is null.
The term I takes into account also the complex phenomena such as the interception by the vegetation and the accumulation in terrain surface depressions which delay the occurrence of surface runoff.
From the analysis of the results obtained by the SCS into numerous small experimental basins, it has been proposed the empirical relation that binds I to the S and which allows to estimate I as I = 0.2S. The value of S is normally attributed through the use of an intermediate parameter, the Curve Number (CN), according to the relation:

$$S = \frac{25400}{CN} - 254 \tag{2}$$

Therefore it follows that the outflow height up to the instant t is equal to:

$$\mathrm{Q(t)} = \frac{[P(t)-(0{,}2*S)]^2}{[P(t)-(0{,}2*S)+(\frac{25400}{CN}-254)]} = \frac{\{P(t)-\left[0{,}2*\left(\frac{25400}{CN}-254\right)\right]\}^2}{\{P(t)-\left[0{,}2*\left(\frac{25400}{CN}-254\right)\right]+\left(\frac{25400}{CN}-254\right)\}} \tag{3}$$

The CN parameter is a dimensionless number and varies from 100 (for water bodies) to about 30 for permeable soils with high infiltration rates. The CN is therefore essentially linked to the nature of the soil, the type of vegetation coverage and the soil moisture conditions prior to the precipitation. As regards the nature of the soil, the Soil Conservation Service (SCS, 1972) has classified the types of soil into four groups

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on the basis of the different characteristics of permeability, from group A with very high infiltration capacity to group D with little infiltration capacity. The operational procedure proposed for the effects of the land use changes assessment provides several phases defined as follows:

- identification of the total area of the subdivision being evaluated;
- identification of the surfaces of the individual specific use of the soil components (roof, parking, green area, ...);
- classification of individual surfaces with the appropriate CN;
- obtaining (automatically) the weighted average CN for the total surface area;
- set a return time and apply the formula (3)to obtain SCS CN Q output from the sub-basin.

The application allows to identify the total area of the subdivision being evaluated and the surfaces of the individual specific use of soil (roof, parking, green zone).
Once the areas are identified, the classification of individual surfaces is possible with adequate CN to obtain automatically the weighted average CN for the total surface area that is equal to:

$$CN_M = \sum \frac{Ai * CNi}{Atot} \tag{4}$$

Where:
CN_M : average weighted CN for the total area
CN_i : single surface CN
A_{tot} : total surface area (automatically obtained)
A_i : single surface (automatically obtained)

As a consequence of this evaluation there is the need to simplify the possible application of BMP to mitigate the impact. The "Service Level Method" (LS) is a BMP selection method designed by the American Public Works Association & MID-America Regional Council for the macro region of Kansas City, USA, which is based on applied hydrology research of the Soil Conservation Service and practice studies recognized in USA.
The LS requirement for the development is determined by the change in runoff as measured by the change in curve number from the predevelopment condition to the postdevelopment condition (Fig. 2).

Change in CN	Impact	LS
17 or greater	High water quality impact	8
7 to 16	Moderate water quality impact	7
4 to 6	Low water quality impact	6
1 to 3	Minimal water quality impact	5

Fig. 2 The relation between the CN change and the impact evaluation and the Level of Service needed

The LS provided by the stormwater management system is determined by applying the Value Rating (VR) provided by each BMP (bioretention swales, bioretention basins, constructed wetlands, ponds, swale/buffer systems, etc.) to the area of the site from which the BMP treats runoff. If the development or project does not meet the definition of development or is otherwise excluded, BMPs are still recommended.

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In particular the steps of the procedure proposed by the American Public Works Association and the MID-America Regional Council (APWA / MARC, 2012) for selecting a BMP are:

- calculate the weighted curve number for pre-development conditions using the SCS-CN method reference;
- calculate the weighted curve number for the proposed development;
- determine water quality measurements, or Level of Service (LS), which compensates for the difference between CN Pre and post-development;
- calculate the weighted Value Rating (VR) provided by the proposed development, including waterproof surfaces, vegetative cover and preserved or replanted vegetation;
- if the weighted VR of the proposed intervention does not meet the LS, a mitigation system can be assumed by applying BMP;
- calculate the weighted VR for the mitigation package;
- realize the actual sizing design of the BMP system.

5 RESULTS AND DISCUSSION

Geographic Information Systems provide the ability to perform spatial analysis and allow to graphically highlight the results of queries on the data related to the map.

This technology allows the capture, storage, analysis, visualization, and the return of information from geographic data. In other words, an interactive mapping system is a tool that allows to analyze the relationships between objects located on the territory.

The added value of this technology is that the data, stored properly, systemized and localized cartographically, can be viewed simultaneously by multiple technicians on the network even from different places (Fig. 3).

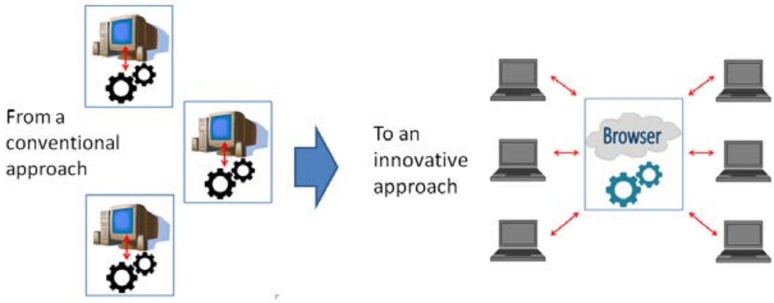

Fig. 3 The shift from a conventional approach Client based to an innovative approach of cloud interoperability

The Geographic Information Systems schematize information in a structure with several layers each containing a single theme and enabling knowledge integration through a multi-sectorial and multi-scale approach. Implementing GIS technology towards online interoperability through Web-GIS permits to answer the challenge to bring together GIS tools and assessment models in a network environment. The Web-GIS was established, precisely to connect all public servers and the information available to manage the map information on the web. The Web-GIS solutions improved with specialized tools help make information

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available anytime and anywhere to the different stakeholders in the network building a common and accessible tool able to guide decision-making power on a science-based approach. The control of the effects of changes in land use in environmental quality, particularly in the management of water resources, can thus become operational on the network through the application of innovative tools.

The application includes the development of a database linked to the designed object to have information about the area, CN, land use, surfaces description of the part of land subjected to change. In this data structure values can be inserted, directly from the Client, with the underlying cartography, and these values will be stored in the map server to constitute the database of the transformation. Therefore, it is possible to create a working layer "Editing" (Fig. 4) on which to edit the new design situation.

Fig. 4 The drawing layer on which new objects are stored

Having identified a project area, new surfaces can be designed representing the different kind of land uses. For each type of land use, and therefore for each surface, in the CN value attribution, new characteristics of permeability can be assigned according to what will be built in those areas (Fig. 5). Each saved characteristics will directly be visible from every stakeholder involved in the assessment.

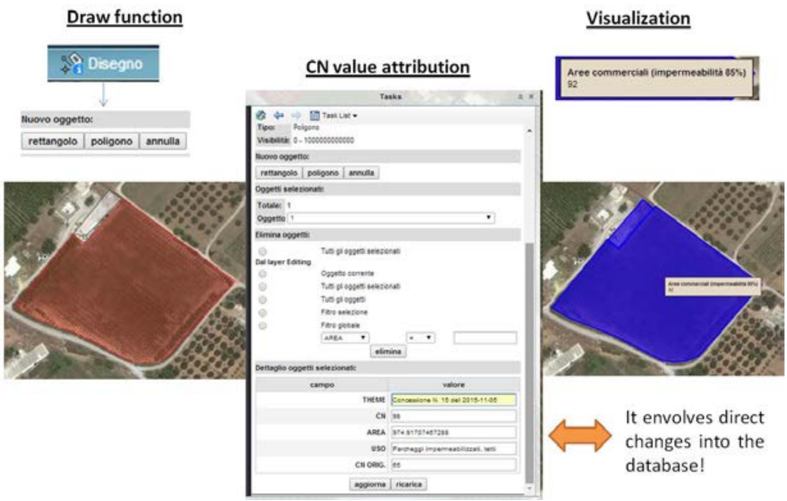

Fig. 5 The flow of procedures provided by the developed web application

The application takes into account the total area and makes it possible to recover the value of the percentage increase of CN that describes the impact that the territorial transformation induces (Fig. 6). At Community level, among the solutions that exist to compensate the loss of soil and its functions is the proposal to establish eco-accounts. It is also hypothesized a soil sealing fee to be collected to be used for soil protection or other environmental purposes (European Union, 2012).

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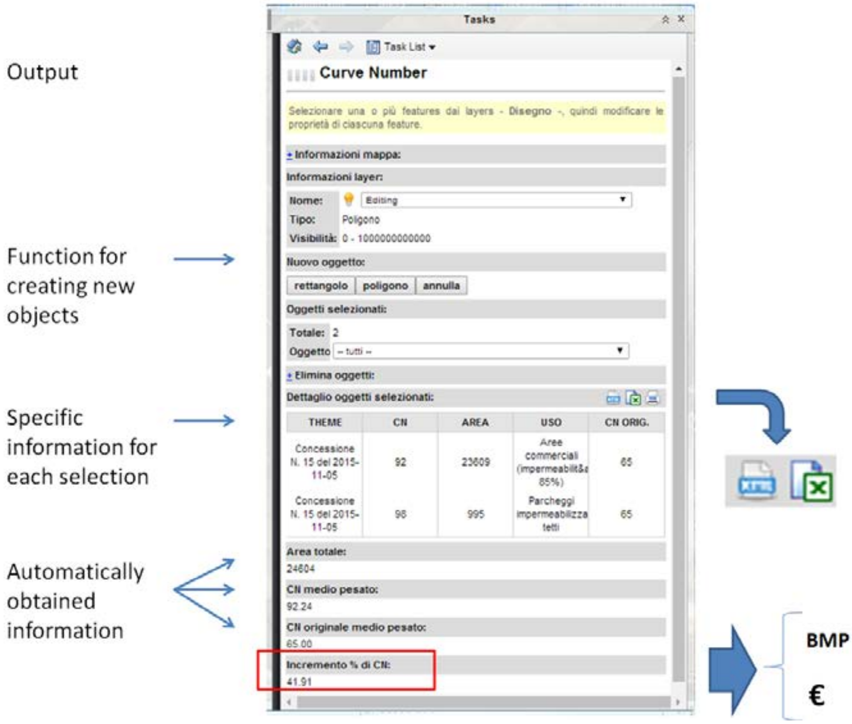

Fig. 6 The output of the application: the results of the evaluation can be used to provide environment taxation or BMP design

6 CONCLUSIONS

The methodology specializes the particular approach established in previous projects extending and implementing GIS technology Geographic Information System towards online interoperability. The target of the methodology and technology implementation is represented by stakeholders who act directly on land such as: public authorities and private professionals.

The implementation of GIS technology Geographic Information System would allow the planner to use the environmental tool to study the impacts of land uses on the project area when performing environment control of supposed land use changes.

The development of ICT solutions integrated with spatial data knowledge must guide the planner towards strategic, reliable and shared decisions in the water sector.

The application of innovative ICT tools in the field of peri-urban regeneration can become a powerful tool, particularly in the water resources management, to guarantee environmental quality control and to avoid land use consumption as suggested by the European Union.

Implementing GIS technology to enhance the comprehension of interactions between the existing multiple aspects, the environmental processes simulation and the impacts analysis of land management activities on water resources can permit the definition of scenarios as key components underlying the political decisions (Di Giacomo, 2016).

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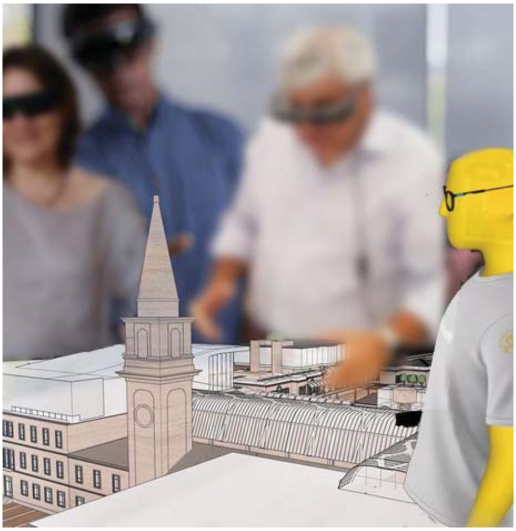

AUGMENTING THE SMART CITY

A "NEW VIEW" FOR THE URBAN PLANNING

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ABSTRACT

In recent years, Augmented Reality has gained interest both for being a technology that offers many possibilities of interaction with mobile devices (smartphone and tablet) and for its potentialities of being used in outside contexts. The recent transition of Augmented Reality from the virtual context of the Video Games -within an indoor ambiance- to the real urban space -within an outside ambiance- is providing new perspectives for urban planning processes, as a result. Referring to this transition, the paper tries to investigate the possibilities of proposing a new view for the urban planning process taking into account the potentialities of the recent applications of the Augmented Reality. At the same time, the paper wonders on the possibility of new perspectives that the Augmented Reality can offer to the research in the sector of the town planning. Using a methodology based on a systemic approach, the paper intends to underline the relations existing between urban subsystems and the use of technology. In these relations, the social subsystem plays a central role, as its components (people living and using the city) can improve the urban smartness by the adoption of responsible and aware behaviors. AR applications in the field of the game (e.g. the phenomenon of PokemonGo) has shown how people are willing to be involved in new ways of fruition of urban spaces as long as they can use their mobile devices and they can share their own experiences on the social networks. This attitude can be properly taken into account within the process of urban governance both to improve the participative procedures and to explore new paths for the aware use of technologies. These innovative research dimensions should be explored carefully and quickly, considering the possible contribution of these values to the urban smartness.

KEYWORDS
Urban Smartness; City as a complex system; Augmented Reality; Smart and Resilient City

1 INTRODUCTION: THE CONCEPT OF THE SMART CITY

In the last few years, the concept of the Smart City has become particularly prominent within scientific debate, representing an opportunity to renew the way of thinking about cities and their social communities. Early reflections, researchs and projects on this subject seem to converge towards the idea that an urban *smart* development is the inevitable outcome of the infrastructural facilities (physical capital) and their continuous innovation, but it also depends on the quality of the human, social and natural capital, intended as strategic factors of development. In this sense, a *smart city* is, above all, a city capable of both meeting the needs of its citizens and respecting environmental rules. The challenge, thus, is to make the city most responsive to the needs of its users (residents) in terms of better quality of services, reduction of environmental impacts (polluting emissions), and decrease in energy consumption, by using innovative technologies (ICTs) (Caragliu et al., 2011).

From a town planning point of view, this does not seem very different from the visions that some scholars (Cairncross, 1997; Mitchell, 1996) had in the last century about the change in the use of the city due to the spread of new technologies. What characterized this vision was probably the collateral role of the new technologies in the development of urban activities at the economic, social and physical levels. More recently, the theme concerning the role of technology is still being investigated, focusing on the possibility of re-defining the urban functional system using new technologies (Aurigi & De Cindio, 2008; Fistola & La Rocca 2001; Willis, 2007). Up to now, and especially as it concerns the Italian situation, the study of the relations between new technologies and the city has been neglected and probably considered as unrelated to the needs of urban planning. At present, instead, technologies are assuming a significant role, and a renewal of the methods and tools used in approaching the city is required.

The definition of a smart city, thus, can assume different aspects, but the real issue seems to be the informed use of technologies to shift the urban system into a *smart* state. Augmented Reality (AR) can boost this transition, enhancing the dimensions of the real urban system and involving the urban subsystems: the socio-anthropic subsystem, as it allows citizens and city-users to have a new perception of the space; the physical subsystem, as it acts on physical spaces, enriching the real scene with adjunctive information or objects.

1.2 SMART CITY: IS THERE A SHARED DEFINITION?

The emergent "smart city" paradigm seems to highlight that the actual challenge consists in making cities more efficient by means of innovating technologies (ICTs) capable of supporting the management, monitoring and functioning of cities.

The Smart City approach, then, assumes that technology is part of the system and is not an additional element in performing urban activities at different levels (economic, social and physical). In this vision, an *intelligent* city is the one that, using technological innovation, spends less, and in the best way, without reducing the quality of services for citizens and firms.

It is undeniable that ICTs play a central role in most of the Smart City projects developed over the last ten years. Ratti (2012) points out their importance, preferring to refer to a *senseable city*, rather than a smart one, that has citizens at the center of its interest (Ratti, 2012). In this sense, ICTs are the means to allow citizens to act within the city.

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Indeed, definitions of and approaches to the Smart City have not yet reached a common vision (Neirotti et al., 2014) and the smart city seems to be more of an urban label than an alternative approach to urban themes (Battarra et al., 2016; Holland, 2008). Papa et al. (2015) have investigated the lexical connection between the words "smart" and "city," underlining the disparities of complexity between them. The analysis, considering roughly 156 smart city definitions, points out the lack of an organic vision of the urban system as a whole that needs attention for the purpose of facing its present challenges (climate change, energy conservation, CO_2 emissions, etc.), rather than an excessive trust in technologies. Concerning the requirement of a systemic vision, Giffinger et al. (2007) state that a smart city "*is not used in a holistic way (…) but for various aspects, which range from Smart City as an IT-district to a Smart City mainly referred at the level of education of its inhabitants.*"

Even though the combination of technological and social components is gaining increasing attention, two different groups of interest can still now be identified in defining the smart city: the industrial and the scientific. The first group has major interest in equipping the city with sensors; the second group should point out methods and techniques able to support urban planning. Currently, contributions are mainly oriented towards defining urban indicators to "measure" whether and how a city is "smart" (Cohen, 2012; European House Ambrosetti, 2013; Testa, 2012; Wien University of Technology, 2012). Rarely do contributions refer to a holistic vision of urban smartness; a vision applied per part (smart building, smart district, smart street, smart infrastructure, etc.) seems to prevail. However, a holistic vision should allow for positive effects through both technologies and social capital (Fistola, 2013; Papa et al., 2013; Ratti & Townsend, 2011). The availability of a good level of human capital, in fact, is considered a factor of competitiveness and territorial capacity of attraction. The active role of the human factor (the anthropic system: the urban actors, residents, city users, tourists) is also becoming increasingly important, because it can significantly affect the success/failure of a city.

In the context of these considerations, this paper examines the relationship between new technology and the city, considering the dimension of games as a phenomenon that must be observed in order to allow urban planners to face the radical changes occurring in present-day cities. The paper concludes by pointing out the possibilities that the use of gamification and augmented reality can offer in improving the town planning process for a real transition towards urban smartness.

2 METHOD AND MATERIAL: THE CITY AS A COMPLEX SYSTEM AND THE TECHNOLOGICAL PUSH

Many scholars (Allen, 1997; Ashby, 1956; Batty, 2005; Bertuglia et al., 1987; Bertuglia & Vaio, 2011; Mc Loughlin, 1969; Nijkamp & Reggiani, 1993; von Bertalanffy, 1968) have argued that the complexity of cities allows us to consider the city as an open and complex geospatial system (Tab. 1).

The theoretical method of the complex systems could be applied in studying the evolution of the urban systems.

Complexity represents the strategic factor able to ensure the evolution of the system itself. To reduce the complexity of the system and to understand its mode of working, the urban system can be structured into different subsystems that are connected to each other.

In particular, according to the aim of this study, we refer to the city as being constituted of five subsystems that are composed of material and nonmaterial elements (Fig. 1). Subsystems are part of a whole that is the urban system and they cannot be ultimately be separated.

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City and the Complex System Properties

Multiplicity of elements composing the urban system Complex systems are made of multiple elements, with different characteristics, functions and structures. Within an urban system, there are material elements (buildings, squares, streets, etc.) and nonmaterial elements (behaviors, economies, societies, etc.). The connections among these elements can vary, differ and diverge: the quality and the types of connection compose a huge and complex system known as the city.
Multilayer structure of the urban system The vision of the city as being composed of multilayers has recently been affirmed. This vision can be helpful in understanding the complexity of the urban system. The number of layers is strictly connected to the level of complexity of a system: the more layers, the greater the complexity. The layers include people, families, neighborhoods, streets, communities, and districts, and they compose different subsystems that, in turn, are created by elements and connections. A city can be intended as a complex n-dimensional system in which the n-layers-subsystems represent its dimensions. ***City as an open system*** As a complex and dynamic system, a city is not in a state of equilibrium. According to non-equilibrium self-organization theory, openness is a crucial condition for the system to evolve towards a balanced state, even though it is a dynamic state of balance. The urban space is a typical open system with a dissipative structure: it maintains connections with outside-producing entropy in the form of waste and non-recoverable energy. Nevertheless, openness and dissipation are basic conditions for complex systems.
Adaptivity and inner dynamics People are the most important elements within the urban system. As individuals, they are active and adaptive (CAS theory), and these characteristics are the main form of complexity. The adaptiveness of an urban system causes inner changes affecting the population, economics and social dynamics of the city.
Nonlinear interactions Within the urban system, nonlinear interactions are generated among subsystems and inside of them (i.e., the allometric relations between population and area). Nonlinearity is the main cause of the complexity of the urban system.
Self-organization of the city As a complex system, the city is characterized by self-organization, and its evolution does not depend on external factors. The components of the system (the agents) transform themselves according to simple and internal rules; lacking a global vision of the total evolution of the system, nevertheless, they tend towards a state of equilibrium, moving from chaos to order.

Tab.1 Analogies between complex systems and the city

If the city is a complex system, it is not possible to plan the system’s future state, as it is complex, non-linear, and stochastic. Therefore, the only way to lead the system towards a sustainable state, compatible with the limited availability of resources, is to manage its evolution in an attempt to minimize the entropy emitted during its evolutionary process (Fistola & La Rocca, 2013).

Among the urban subsystems, the *social subsystem* represents one of the *generative* systems of the city, and its components are both the peoples living in and using the city (static component) and the connections (dynamic component) among them.

2.1 THE SOCIAL SUBSYSTEM AND THE INNOVATION TECHNOLOGY

Focusing on the social subsystem, it is possible to observe that citizens’ behaviors have deeply changed because of the technological revolution and the diffusion of the Internet. People are rapidly modifying their habits by introducing the use of new technology into their daily lives. At the end of 2017, the Internet penetration rate in Europe was about 85% of the total world population (Fig. 2).

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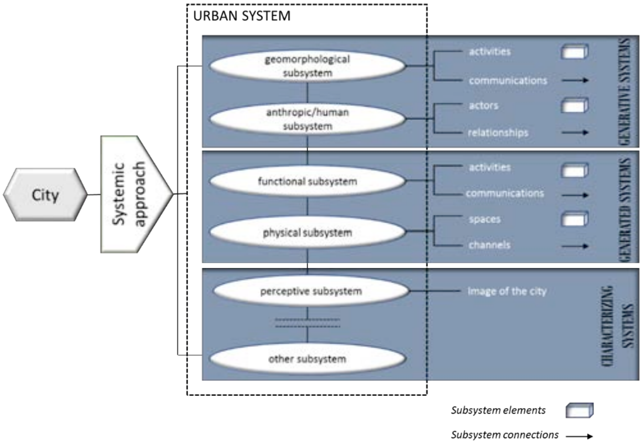

Fig. 1 The urban system and the five sub-systems identified

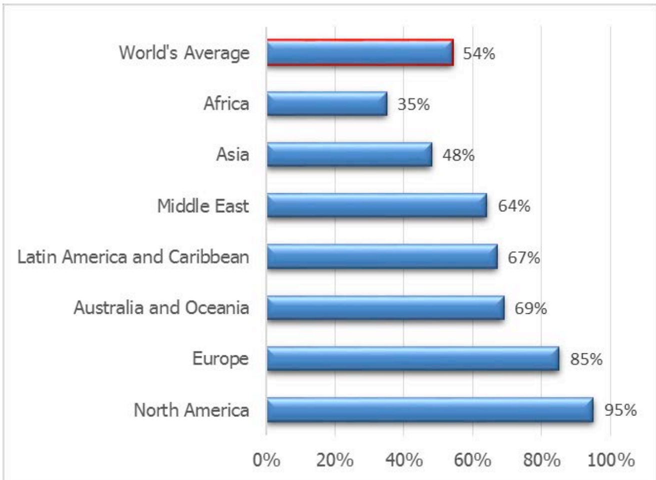

Fig. 2 The Internet world penetration rate per regions calculated on a population of about 7 billion of people (source www.internetworldstats.com, accessed in June 2018)

This means that, around the world, the number of connections to internet and the consequent consumption of data are increasing at a rate double that of the birth rate (Fig. 3).

As a matter of fact, technological interaction has taken over a significant portion of the dynamic of human relationships. An example can be the "Facebook effect" on our interpersonal relationships and the importance in social implication assumed by the number of "likes" to gain a social assent (Reich et al., 2018). It is also possible to state that technological revolution impacts each urban subsystem and especially the social subsystem. Important is to manage the change instead of try to hinder it.

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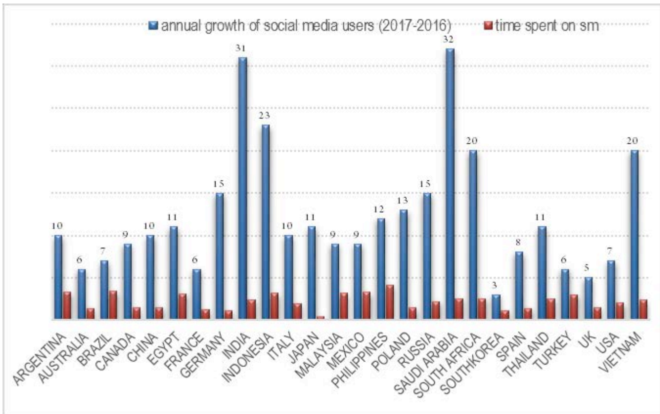

Fig. 3 Percentage of the growth of users of social media (Facebook, and others) and average of time spent per day (survey of users aged 16-64; source Digital in 2017 www.wearesocial.com, accessed in June 2018)

So far, games, software and apps have changed our lives deeply. This also depends on the level of attention that we devote to the technological dimension through our personal digital devices. The technological convergence that considers the smartphone as a tool useful for receiving, elaborating on and exchanging data and information has determined the vital function of every personal device. Furthermore, the diffusion of social networks has created a personal cyber dimension to which it is hard to renounce: nowadays, it is tough to resist answering our mobile when we receive a message (SMS, WhatsApp, Instagram or other), even in the most improbable situation. The use of the smartphone has been also considered as an addiction (South University, 2013). Some scholars in psychology (Gibson 2011; Merlo 2007; Yadav & Yadav, 2016), in fact, have observed certain problematic behaviors due to the excessive use of smartphones (absence of perception of reality and surroundings, aversion to socialization, loss of face-to-face relationships). They remark that the problem could become as serious as substance abuse, even though, obviously, the consequences on health are deeply different. The *cyberkrank* (Spitzer, 2016), thus, also seems to have infected people when they are in a group, at close range, and they cannot help but use their smartphones rather than communicate with each other, driven by the need to be "connected." At present, it is possible to say that technology has a high level of attention in everybody's life and that a significant portion of our daily activities has changed due to the technological push.

2.2 VIRTUAL WORD AND AUGMENTED CITY

The extreme impact of technology on the social system is quite likely the growth of a parallel dimension to which correspond the born of a new urban subsystem: the communicational one (Fistola, 2001).
From the first studies dealing with the urban transformation of the city, due to the Innovation Communication Technology (ICT) at the end of the 90s with the seminal books by Steve Ghrahm in UK (Graham & Marvin, 1996), William Mitchell in USA (Mitchell, 1996) and, before all, the researchers led by Corrado Beguinot and his research group in Italy (Beguinot, 1989), we are now in a new phase of the development process. In this step all the urban subsystems are affected by ICT and the urban system as a whole evolves in time and space by generating an enormous quantity of data (big data) collected by artificial and anthropic sensors.

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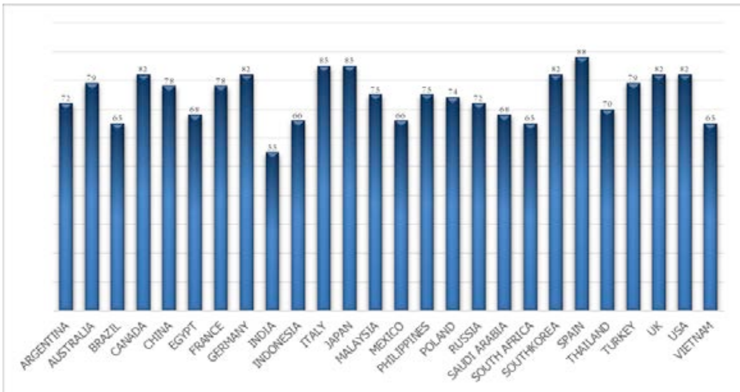

Fig. 4 Percentage of mobile user penetration per country compared to national population, 2017 (source Digital in 2017 www.wearesocial.com, accessed in June 2018

At this time thanks to ICT everybody can participate in the development process of the city by writing a piece of the urban open source code (Carta, 2018). In order to play this role urban actors, (the components of socio-anthropic subsystem), can amplify theirs faculty to envisage a future dimension of the city by "seeing", in the present spaces (physical subsystem), a new composition and a different allocation of urban activities (functional subsystem). The augmented reality (AR) offers this possibility in a more efficient way of the virtual reality (VR), that in the last decade has polarized the attention of scholars and company (for the potential implementation for the videogames). The AR, instead of the VR, allows players to remain in the real physical space and to have experiences that have nothing of either a physical or a real dimension. In other words, the experience of the augmented reality (probably could be more correct to speak about: mixed reality) allows persons in a real social system to interact in a real and physical, but "augmented," city (Tab. 2).

Virtual Reality	***Augmented Reality***
It replaces the real world	It enlarges the scene, but the action occurs in the real world
It replaces the real scene through the building of a virtual ambience	It enriches the real scene through information aimed at solving complex tasks
The visual feedback is totally controlled by the digital system	The visual feedback is mixed (partly controlled and partly not)

Tab. 2 Main differences between Virtual Reality (VR) and Augmented Reality (AR)

By considering the worldwide (but ephemeral) success of the game called: "Pokemon GO" in 2016, in which the players have to catch the Pokemons going around inside the city, forming hunters groups, and looking for preys in a specific places of the urban context (like monuments, historical sites, and so on), the game, thus, could be a new way to drive technology within the city and to affect the citizen's ongoing life (Cecchini, 1993). Maybe, playing an urban game will become a way to make it possible, in the very near future, to drive new behavior and define a new way of interacting with the urban subsystems. On this concept, Pablo Chillon (2012) has argued: "the continuous *dripping* of game-like initiatives in urban contexts, and the increased participation of full engaged multi-players can also help to create new opportunities for business

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and green economies" (Chillon, 2012). The augmented city, thus, can represent a new development phase of the smart city, in which technology allows the citizens to really see the modifications of their urban system and offers them to be involved (meant as active participation) into the urban choices, by overcoming difficulties due to the understanding of technical documents or project. The AR offers also new possibilities in all the phases of town planning: for instance via telepresence, it is possible for planners, who are physically locates in different places, to work together on their tridimensional project. In this regards, it is possible to remark that the ICTs are radically changing the town planning process. This process have to bicome a management process in which the development of the urban system can be monitored through the appropriate use of the big data and the trend of the city can be foreseen by the correct application of the new technological innovation such as AR, VR, 3D city modeling, BIM-GIS and so on.

3 RESULTS AND DISCUSSION: AR AND THE NEW URBAN PLANNING

Remaining within the boundaries of the real city, the AR affects all the urban subsystems: the social subsystem, the functional subsystem and the physical subsystem. At the same time, the psycho-perceptive subsystem (Lynch, 1960) is also involved, if we consider that the AR supports the real world with additional information and does not build a new world avulsed from the real one (Webster et al., 1997). Some scholars envisaged this capability to establish a correct balance between new technology and the management of city transformations (Aurigi & De Cindio, 2008). The augmented reality will allow urban planners to consider the opportunities and risks connected to urban transformation, permitting them to preserve fundamental resources. By using augmented reality, it possible to redefines the urban space (in its physical and functional organization). The gaming dimension could be significant in this sense. The new games that adopt AR allows players to meet in the real space by demolishing the solipsistic attitude of the canonic videogame. There is something that has been radically changed: the urban system has become the physical context of the game.
Considering Pokémon Go as a phenomenon that can synthetize the relationship between the use of new technologies and the city, it is possible to point out some positive and negative issues affecting the urban subsystems (Tab. 3).

Urban subsystems	***Positive effects***	***Negative effects***
Physical subsystem	Outdoors vs Indoors Push to explore the city New landmark locations	The consideration of the city as a mere playground The lack of attention to urban patterns
Functional Subsystem	Use of geospatial disciplines and innovative procedures to map the city Support for administrators in monitoring city representation Improvement of urban points of interest, including for the promotion of tourism to the city Monitoring of landmark locations Updating of information about the state of the city Improvement of urban requalification policies	Scarcity of planning the events to catch the monsters Personal security Illegal use of personal data Capturing of personal data Careless behavior in regard to urban automotive traffic Uncontrolled overcrowding
Social-anthropic subsystem	The elimination of "digital solitude" Push to meet people outdoors and create communities	Resident acceptance Personal security Capturing of personal data Social competition Increase in aggressiveness

Tab. 3 Positive and negative effects affecting the urban subsystems

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Positive as well as negative effects can be considered in the implementation of urban policies aimed at improving urban requalification and global urban livability (La Rocca, 2015) . The case of Pokémon Go allows us to consider that the game generates new urban ways of achieving fruition of the city, improving participative processes and allowing people to develop new relationships that materialize within the social network.

4 CONCLUSION

The digital revolution is still in progress and it will produce further modifications inside the human relations, too. Moreover, it is important to take into account that some phenomena involve directly the urban system.
Technological innovation is bringing about the miniaturization of devices and magnification of the space of action: from Eniac (which occupied a surface of 200 sqm.) to the personal mobile phone, and from the game room to the city. As Batty (2013) stated, “the digital revolution has moved computation from the main frame to the smart phone and has seen digital usage spread out from the laboratory to the city, the nation and the globe”. Another interesting phenomenon relates to the *wearability* of technological devices that are progressively finding the ways to be integrated with the human body.
In this regard, it is possible to imagine that the future smart city will have an “augmented dimension” that will be possible to explore, using wearable devices, while walking, living, using the “real city”. These new trends will foster urban smartness towards increasing levels by spreading technology inside the city and all around us. The AR allows us to share a real space in which to define a virtual comparison; space and mind come together in a new digital environment for the development of collective intelligence (De Kerchove, 2015).
The main aim is to create connections so that the digital flows will build the future city and will redefine all urban functions. In this scenario, the role of the social subsystem will be decisive. People will use the city in innovative ways thanks to the AR and maybe urban gamification, which will allow them to explore physical spaces enhanced with new content.
The interest of the urban planner, connected to the informed use of AR, is the object of recent applications, as of now. The “Urban Plan AR” developed at Heriott Watt University, for instance, is an interesting first application. The app developed by the research group, allows town planners and designer to depict the future transformation of an urban area using the AR, having the opportunity to verify ex-ante the efficiency of their project. Furthermore, this opportunity can facilitate the participation of non-expert users in the decisional process of transformation. This example could give an idea of the potentialities that ICTs offer to urban planning, both in the project phase and in the decisional phase. This is the sense, in our opinion, to consider that technologies are the key factors for generating a real “new” urban smartness.

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The authors gave a joint contribution to the paper’s conception and design, introduction and concluding remarks. Rosa Anna La Rocca developed the methodological approach to the topic and the relation between subsystems and innovation technology (§§ 1, 2.1 and 2.2) Romano Fistola developed consideration about the augmented reality (§§ 2.3 and 3).

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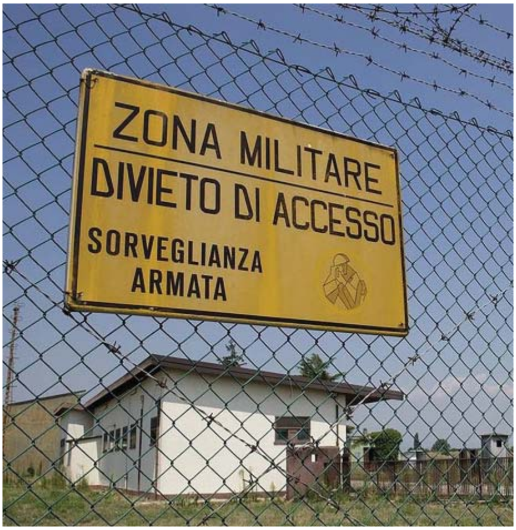

REGENERATE, RETRAIN, REUSE

A GIS BASED ON SPATIAL MULTI CRITERIA ANALYSIS FOR THE REDEVELOPMENT OF ABANDONED MILITARY AREAS IN PISA

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ABSTRACT

This work aims at the reintegration into the urban fabric of three abandoned barracks in the historic centre of Pisa. In particular were analysed a military complex, a former military district - both dating back to the beginning of the 20th century - and a former monastery, which became military property in the 1800s. They are composed by several buildings of considerable architectural importance and wide green spaces now completely inaccessible. With the aim of defining new uses compatible with areas and with the needs of citizens, but especially with the new requirements for sustainable development and the constraints of historic centres, was used a GIS based Multi-Criteria-Decision-Making approach. The integrated use of GIS with MCDM allows to define different spatial criteria and indicators and to make explicit the contributions of the different choice options to different criteria that define the problem. The major phase of the research concerned the determination and quantification of the impacts that the new uses could have on the urban fabric. For this purpose was used the ELECTRE 3 method, developed in a GIS implemented through a proprietary programming language. This model allowed to obtain a classification of the three barracks for each of the six new hypothetical uses defined by involving the stakeholders. The intersection between the results of the technical analysis performed with the aforementioned methods and the preferences defined by the stakeholders, allows locating the three most suitable new functions in the barracks.

KEYWORDS

Spatial Multicriteria Analysis/Evaluation; GIS; ELECTRE 3 Method; Urban Regeneration; Military Barracks; Pisa

1 INTRODUCTION

This research focuses on one of the most recurring themes in the Italian centers: the disposal of State assets, with particular reference to the estate of Defense. The main causes of this phenomenon are the radical transformation of national defense strategies and the deep economic crisis that has gripped the Europe from 2008. The buildings that formerly hosted young soldiers for the duration of compulsory service, are no longer functional to the current defense model, this implied an adaptation of the entire logistic system that has affected all the country, causing the abandonment of military areas which lose their original function and creating large "urban voids". The theme with the related reconversion problems has also significantly affected the historic center of Pisa, which has inside it 50'000 square meters of dismantled military areas. Therefore the objective of the study is to implement an evaluation method which create an agreement between multiple reuse alternatives and allows to deepen the most problematic aspects to reach consensus on one or more alternatives.

2 THE CASE STUDY

The theme of the recovery of the existing building heritage in Italy is full of aspects and issues that invoke resolutions. There are either punctual and limited intervention of reuse on a single building, either on multiples or areas, defined in a typological way as "specialized areas" (Storelli & Turri, 2014)". Regeneration of military areas analysis needs to consider several factors: the regulatory requirements, but also the multiplicity of possible perspectives and their impact on portions of territory sometimes untouchable, rich of peculiarities and constraints of a historical and architectural nature. Nowadays, there are three military areas completely abandoned localized in the historic center of Pisa. That problem was faced using a decision aid approach based on the application of a Method of Multi Criteria Spatial Analysis. With the aim of achieving, for each area, the consensus on a reuse scenario, we divided the study into three phases:

- a first phase in which has been analyzed the regulatory framework and the current status of the areas; we also identified the main stakeholders and new uses for use compatible with the constraints of the historic center;
- a second phase in which was applied the Spatial Multi Criteria Analysis;
- a third phase of application of the ELECTRE method (Roy, 1968) which led to a classification of the various scenarios consistent with the results of the study and suitable to solve the problem.

2.1 ANALYSIS OF THE PROBLEM

The study areas, hereafter renamed "ALTERNATIVES" are:

- ALTERNATIVE 1: "Vito Artale" barrack, a complex of post-unitary building that still includes an entire block of the historic district of Cathedral Square (Fig. 1);
- ALTERNATIVE 2: the former "Monastery of San Vito", the headquarters of the Financial Police, definitively abandoned in 2007 and located on the long historical river of the city (Fig. 2);
- ALTERNATIVE 3: the former military district "Curtatone-Montanara", abandoned since 1994 and equipped with one of the largest green spaces of the urban fabric (Fig. 3).

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Fig. 1 The "Vito Artale" barrack in St's Maria District

Fig. 2 The former Monastery of San Vito

Fig. 3 The former Military District "Curtatone-Montanara"

Over the years, the most concrete reuse proposals were put forward mainly by 5 stakeholders: the Municipal Administration (Fontanelli & Nigris, 2004), the University, the Real Estate Fund for Housing, citizens and associations. To identify series of hypotheses for the reuse of the areas (GOAL FUNCTIONS) to be located in the barracks, each stakeholder was interviewed with various methods of investigation. For citizens and local associations we made a specific interview on about 400 people, while for the other interested stakeholders, interviews were made with the competent offices. The uses, resulting from these interviews and compatible with the requirements on the historic center, can be summarized in Museum, Service Centre, Private Housing, Student Residence, Tourist Structure and Conservatory. Subsequently, the study focused on the definition of the three uses for the three alternatives that were the most appropriate with regard to the morphology of the areas and the needs of the citizens. About it, the problem was even been analyzed from the "spatial" point of view through the use of the GIS that allowed to localize the activities and to analyze

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the data for evaluation of the problem. In this way we have managed to evaluate the complex system of relations that the activities establish between themselves and with the territorial morphological system.

2.2 APPLICATION OF SPATIAL MULTICRITERIA ANALYSIS

Multi Criteria Analysis needs to work on simple factors, the criteria, which describe the problem exhaustively and that can be analyzed separately. The criteria can be qualitative, quantitative and/or spatial (Malczewski, 2006); they are therefore the measurable aspect of the judgment. If the problem is very complex the criteria can be divided into sub-criteria that better represent some aspects of the evaluation. In this way we obtain a two-dimensional representation of the cause-effect relationships between the activities of the project and the social and environmental factors potentially sensitive to changes (Fig. 4).

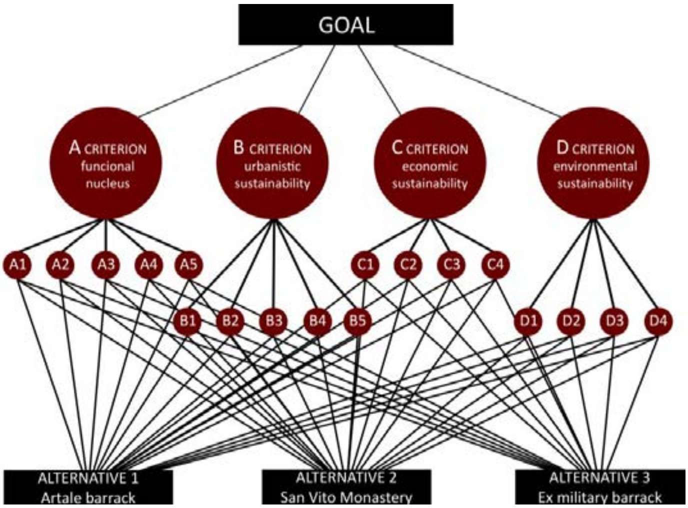

Fig. 4 The structure of the Spatial Multi Criteria Analysis: Goal function - criteria - sub criteria - alternatives

<u>The Choice Of Criteria And Sub-Criteria</u>

<u>CRITERION A: FUNCTIONAL FEASIBILITY</u>. This criterion aims to evaluate the compatibility of alternatives with the selected goal functions. The criterion has been divided for each goal function into five sub-criteria (A1, A2, A3, A4, A5) that identify in an overall way the possibility of being able to distribute the functions of each goals in the three alternatives. The most important characteristics are: the heights of the rooms, the accessibility, the availability of usable square footage, the presence of services and premises for the equipment and the possibility of breaking down the architectural barriers.

<u>CRITERION B: URBAN SUSTAINABILITY</u>. To ensure sustainable choice, we must consider three inseparable dimensions: the economic dimension, the environmental dimension and the social dimension. Territorial planning has implications in all three dimensions. The sub-criteria defined for criterion B therefore relate to the consistency with the existing urban planning forecasts (B1) and with the functions present in the area of

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influence (B3), relations with other services (B2), accessibility and mobility (B4) and the level of livability of the district (B5).

CRITERION C: ECONOMIC SUSTAINABILITY. For the economic dimension we have identified four sub-criteria that consider not only the quality of the intervention in relation to its uniqueness (C1), but also the costs for the development of feasibility studies (C2), for interventions on urban scale (C3) and for the preventive restoration of places (C4).

CRITERION D: ENVIRONMENTAL SUSTAINABILITY. The data reported by ISPRA (in the last 50 years Italy has consumed about 7 square meters per second of land) highlight the situation of our country, where the consumption of soil will lead soon to the saturation of urban areas (ISPRA, 2017). Reconversion of abandoned buildings could be the solution. In this sense, the identified sub-criteria of the criterion D refer to the environmental impact (D1) and to the maximization of the green areas in the historical centers (D4), to the energy efficiency (D2) and to the preservation of the historical vocation (D3).

Asseigning Weighs To The Criteria And Sub-Criteria And Choosing Of The Indicators

To assign an order of importance to the set of criteria and sub-criteria, was necessary to assign them a "RELATIVE WEIGHT", i.e. a numeric dimensionless value. There are many weight assignment techniques; the one used was the Pairs Comparison Method, also called the SAATY's Method of Eigenvalue (Saaty, 1988). This method consists on comparing in pair of criteria and sub-criteria, related on their performance. This comparison is associated with a number chosen on a linear scale (the Saaty's Scale). The result is a positive and symmetrical matrix from which, through the calculation of the Maximum Elevation, the Coherence Index and the verification of the Consistency Ratio - we obtained the RELATIVES WEIGHTS (Saaty, 1980). Once we define the weights, there was the most delicate phase of the choice of Indicators. The Indicator is the numerical element that allows, defining in synthetic, measurable and objectively verifiable terms, the sub-criteria. From the nature of the sub-criteria and the heterogeneity of the elements to be quantified, each indicator can be qualitative or quantitative and can be represented with different unit of measure. The following tables summarizes the method of processing the sub-criteria indicators and a specific example of one of these. After defined the weights and indicators, we proceeded to the application of the ELECTRE Method: the acronym comes from the French term *"ELimination Et Choix TRaduisant the REalité"* and it is a MCDM that allows to define a ranking of the alternatives which respect the evaluation criteria outline.

A Wij=0,204	**A1** **A2** **A3** **A4** **A5**	qualitative indicator Available areas for the localization of the new decided uses in relation to 18 meta projects	m^2	Survey of the status of the areas and processing using the AutoCAD technical drawing program.

As an example, is reported the study for the construction of quantitative indicators of the sub-criteria of criterion A (A1, A2, A3, A4, A5) for the goal function "Student Residence". In the Fig. 5 there are four different colors, each for the different use of the barrack: the spaces for housing and public green, but also the spaces for collective services and administration were considered. The same dimensional study was done for the additional five goal functions.

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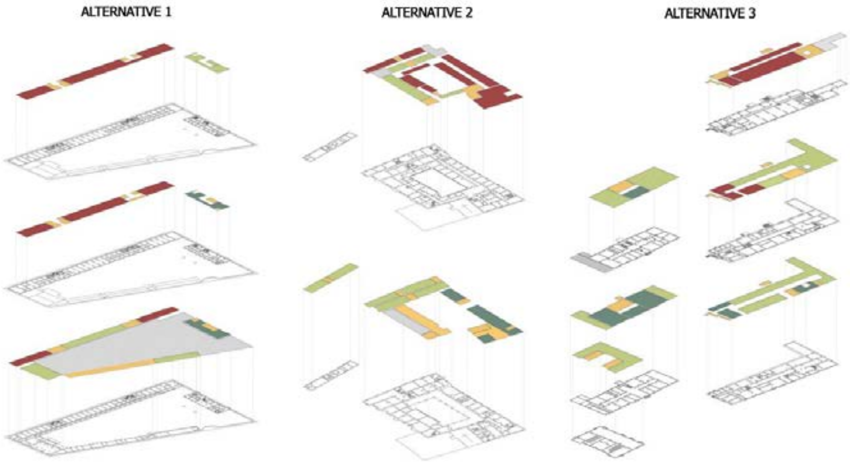

Fig. 5 Study of indicators of sub-criteria of Functional feasibility (Criterion A) for the goal function "Student Residence" (red color: student housing; green color: collective spaces; yellow color: services; dark green color: administrative spaces; grey color: public spaces)

criterion	sub criteria	indicator	U.M.	processing method
B Wij=0,352	**B1**	qualitative indicator Verification of the compatibility of the intervention with the current regulatory framework	Valuation scale 0 - 1	Traditional analysis of the current regulatory framework
	B2	quantitative indicator Calculation of the average distance between the studied alternatives, the services and activities related to the Goal Function	m	DIJKSTRA ALGORITHM for minimum paths and average distances; data processing through functions implemented within sw GIS
	B3	quantitative indicator calculation of the percentage presence of residential house numbers within a 500 m influence radius from each studied alternative	%	Data processing through functions implemented within sw GIS
	B4	quantitative indicator Calculation of the average distance from the study alternatives to the main nodes of mobility and urban accessibility	m	DIJKSTRA ALGORITHM for minimum paths and average distances; data processing through functions implemented within sw GIS
	B5	quantitative indicator Calculation of the percentage presence of abandoned buildings within a 500 m influence radius for each studied alternative	%	Data processing through functions implemented within sw GIS

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universities, restaurants, bars, museums, art galleries, exhibition centers, multi-purpose centers, theaters, cinemas and urban parks. The greater proximity of the selected macro category to each of the three alternatives was evaluated more positively than the others.

macro categories	business categories included	ALTERNATIVE 1 medium distance (m)	ALTERNATIVE 2 medium distance (m)	ALTERNATIVE 3 medium distance (m)
A	bike sharing	1811,5	1880,8	1627,5
B	bus stop, bus station	2620,1	2636,7	2496,0
C	parking	2830,6	2439,9	2648,3
D	railway station	1477,6	1433,6	1740,4
E	university, school	874,3	1075,1	1242,0
F	restaurants, fast food, bars	846,4	937,5	1070,2
G	libraries, study rooms	1089,0	1271,7	1351,3
H	museum, art galleries	1209,4	1290,3	1559,6
I	university structures	824,4	976,6	1149,6
L	shops, supermarkets	983,5	1007,2	903,4
M	administrative structures, offices	929,4	997,3	1001,0
N	associations, recreational clubs	1310,4	1361,2	1091,7
O	Theater, cinema, green park	980,0	1076,4	1152,0
P	b&b, hotel	704,5	900,6	1226,3
Q	sports facilities	1372,5	1337,0	1160,9
R	financial services	973,7	878,4	784,9
S	student residences	1610,5	1779,2	1643,2
T	health facilities	1268,5	1321,6	1442,7
U	conservatory	1851,1	1954,8	2137,2

Fig. 6 Study of indicator of sub-criterion B2 for the Goal Function “Museum”

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criterion	sub criteria	indicator	U.M.	processing method
C Wij=0,207	C1	quantitative indicator Counting of similar and / or equal functions	number	Data processing through functions implemented within sw GIS
	C2	qualitative indicator Evaluation of the need for further study on study alternatives	Valuation scale 0 - 1	Technical evaluation
	C3	quantitative indicator Calculation of the cost of site preparation of each alternative for the Goal Functions	€	Measurement of the areas to be demolished or reconstructed using the AutoCAD technical drawing program
	C4	qualitative indicator Evaluation of the necessity of preventive actions for the safety of the study areas	Valuation scale 0 - 1	Technical evaluation

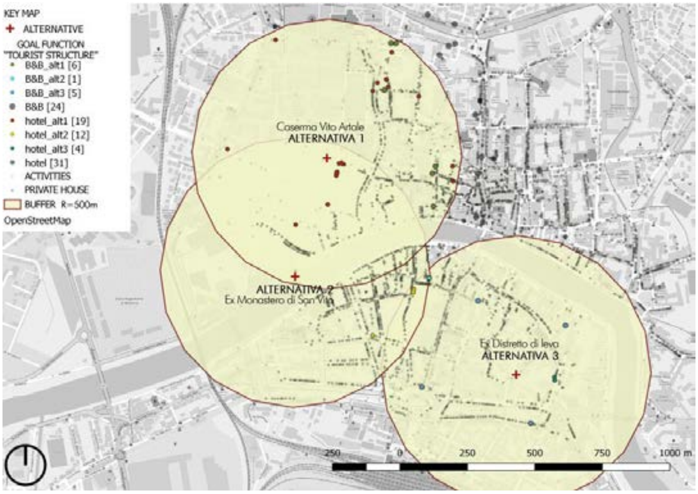

Fig.7 Study of indicator of sub-criterion C1 for the goal function "Tourist Structure"

For the set of sub-criteria that are part of criterion C we showed as an example the sub-criterion C1, i.e. the presence of similar activities within a radius of influence of 500 meters from each barracks. In Fig. 7 is represented the study carried out on the goal function "Tourist structure": for each of the three alternatives have been counted all the tourist structures and all the hotels. In this specific case the positively evaluated area was the one containing the least number of similar functions. For some objective functions, the presence of similar functions could facilitate the "natural" reconversion of the place, inserting it in existing thematic paths as "the museum network" for the museum function and the "network of associations" for the service center function; for others, however, which are part of the sphere of services (tourist structure, student residence, private residences and conservatory) distribution on the territory is necessary to ensure the right functional mix.

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criterion	sub criteria	indicator	U.M.	processing method
D Wij=0,250	D1	qualitative indicator Evaluation of the acoustic impact of the Goal Function on each of the study alternatives	Valuation scale 0 - 1	Data processing through functions implemented within sw GIS
	D2	quantitative indicator Calculation of roof surfaces suitable for hosting integrated photovoltaic systems	m^2	Measurement of the areas using the AutoCAD technical drawing program
	D3	qualitative indicator Evaluation of the coherence of the Goal Function with the historical and architectural vocation of the study alternatives	Valuation scale 0 - 1	Technical evaluation
	D4	quantitative indicator Summation of public green areas and those with free access within 500 m of each alternative	m^2	data processing through functions implemented within sw GIS

For the family of the criterion D we can take as an example the indicator D4, i.e. the maximization of free green areas in the historic center. The indicator has the task of assessing the presence of public green areas always accessible within a range of 500 meters from each of the three alternatives. For the calculation of this indicator we have considered only the green areas of the historic center and their dimensions, distinguishing the purely private green areas from public areas. Here, the "Service Center" goal function - hypothesized as a shared laboratory of associations and cooperatives - requires a public green area to carry out social and cultural activities in the neighborhood; then the free areas in the three barracks are counted between the transformable areas and useful for the purpose of the sub-criterion. For other goal functions, such as the accommodation structure instead, most of the permeable free area has to be used as a space of pertinence reserved for the structure (car parks, reserved entrances, etc.), leaving little space for public parks. The areas of pertinence - calculated on the basis of urban indexes for these structures - will in fact be removed from the total count of the green areas (Fig. 8).

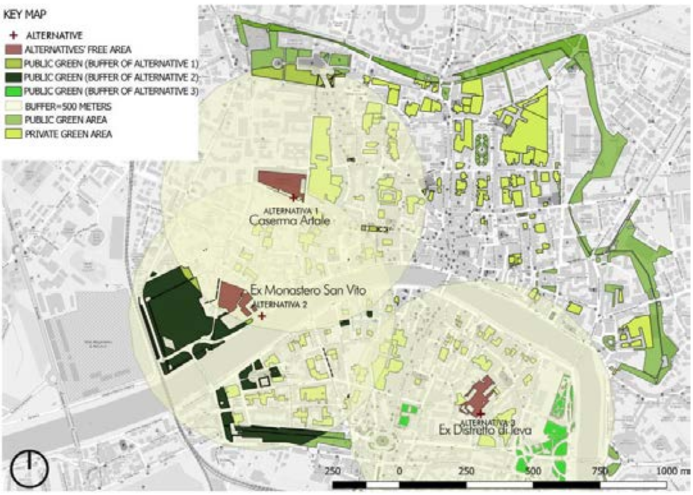

Fig. 8 Study of indicator of sub-criterion D4 for the goal function "Service center"

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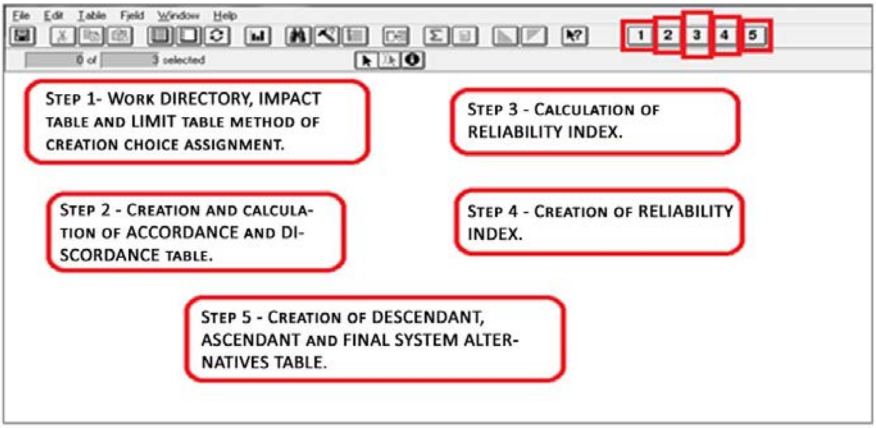
2.3 ELECTRE 3: THE RANKING OF ALTERNATIVES

The three decision alternatives can be represented in the physical space of the area of the study area. Through the construction of a dedicated application within the software and written directly in AVENUE language, was possible to develop the phases of the ELECTRE 3 method in the GIS environment. As in Fig. 9, the process of classifying spatial decision alternatives is divided into five phases.

Fig. 9 Software's structure and description of the computational steps



In the first two phases all basic information were loaded. After quantifying the indicators for each sub-criterion and establishing the relative weight to be assigned to the various criteria and sub-criteria, we proceeded to build the three thresholds of each indicator of each sub-criterion. These thresholds provide the software with all the information necessary for the classification of alternatives (Lapucci, Santucci & Cofrancesco, 2009) and specifically: the Preference threshold serves to distinguish a strong from a weak preference; the indifference threshold characterizes situations of indifference (i.e. when it is not possible, among the performances of alternative actions, to define a preference, even if weak); finally, the threshold of Veto in which the actions are considered incomparable because they are too different. Once this data has been entered into the software, an evaluation direction was even inserted for each of the above mentioned sub-criteria; in case 1 was chosen if the value of the indicator indicates an aspect to be evaluated positively and 2 if the value of the indicator indicates an aspect to be evaluated negatively. In order for an alternative to be preferable to another, it is necessary that the reasons in its favor are sufficiently strong compared to the opposite ones. Therefore, the software provides two orders, one increasing and one decreasing the three alternatives on each goal function: from the most suitable barracks to the least suitable barracks and from the barracks less suitable to the most suitable barracks. The intersection of these two rankings indicates the most suitable alternative (final ranking) based on the highest score. At the end of the analysis is established for each goal function the most suitable barracks: for the "Artale" barrack are identified the student residence, the private houses, the museum, and the tourist structure; for the former Monastery, the winning goal function is the museum, and finally, the district service center for the former district (Fig. 10).

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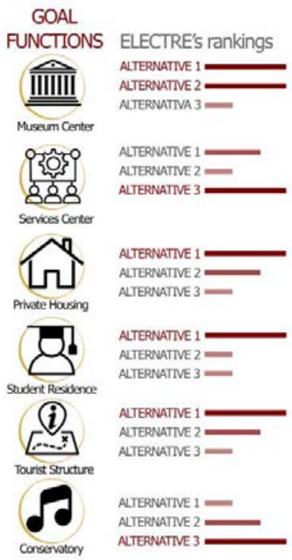

Fig.10 ELECTRE's rankings

3 ANALYSIS OF THE RESULTS AND THE DEFINITIVE CHOICE

To reach the final choice is necessary to face other questions: how can we choose among the goal functions the best for the three areas of study? What are the functions most desired by the stakeholders interviewed and really suitable for the abandoned places in question? To be able to answer these questions, we decided to independently evaluate the results of the technical analysis and the results of the interviews of the stakeholders, reworked to obtain a priority scale of the six proposed projects.This scale was constructed using the Pairs Comparison Method already used to attribute weights, with which each stakeholder has given a weight of all the goal functions. The task of the technician, who prepares the assessment, is to ensure that the final choice reaches the right compromise between the three functions declared more strategic by the

	Municipal Administration	Real Estate Fund for Housing	Associations	Citizens	University	TOTAL	RANKING
Museum	0,187	0,101	0,160	0,295	0,192	0,935	II
Service Center	0,094	0,101	0,296	0,228	0,097	0,816	III
Private House	0,232	0,285	0,082	0,075	0,075	0,749	IV
Student Residence	0,274	0,304	0,206	0,174	0,357	1,315	I
Tourist Structure	0,099	0,109	0,088	0,109	0,103	0,508	VI
Music Center	0,114	0,101	0,168	0,119	0,176	0,678	V

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stakeholders (political evaluation) and the three barracks declared most suitable by the MCDA (technical evaluation). The results of the two evaluations are evaluated in a unitary way to arrive at a final choice that considers the best from the technical point of view and the most necessary from the political point of view. The goal functions declared priority over the others according to the stakeholders are: the student residence, the museum and the service center. If we intersect this data with ELECTRE rankings we obtain the following solutions: the student residence for the "Artale" barracks, the service center of the former Lever District and the Museum both for the former Monastery and for the "Artale" barracks ". More evaluations are necessary to solve the problem of the "Museum" function. Both the area of the former Monastery and the "Artale" barracks are yet included in consolidated tourist and cultural itineraries linking the fulcrums of Pisa (the Tower and the "Galilean Citadel" with the riverfront). The "Citadel" is today a large public green space, little used for musical and exhibition events. The complex of the old monastery is developed in this area, and its eventual reconversion in the museum, would enhance one of the most coveted projects for the city of Pisa: the great MUSEUM PARK which also includes the Museum of Calculation and the historic walls. Also the area of the "Artale" barrack is developed on one of the oldest axis of Pisa but it has an important peculiarity: its main buildings are organized like private spaces - housing and rooms - and collective spaces. This vocation leads to a big opportunity: the reconversion of the old military headquarters offers the city about 200 new apartments quickly. For that and for greater consistency with the results of the MCDA conducted, the museum will be hypothesized in the former monastery, keeping in mind that would be more appropriate to proceed through a further Multi Criteria Analysis to obtain a more transparent result for the problem. In Fig. 11 we can see how the two assessments made can be intersected.

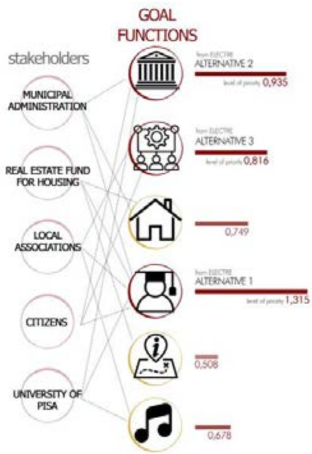

Fig. 11 The intersection between the political evaluation and the technical evaluation

4 CONCLUSIONS

One of the recurring problems in the choices of territorial planning is the evaluation of alternative scenarios. In order to choose the preferred, it is necessary to take into account the effects of the different projects and the preferences of the actors involved in the process. The method that we have implemented to lead the analysis allow to reduce the problem complexity, giving a simplified evaluation scheme.

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The use of the ELECTRE method allows to make a real selection of the possibilities and to better determine which are the most valid choice alternatives on purely normative and technical elements. In the field of sustainable development Multi Criteria evaluations offer the possibility to objectively compare all the components of the problem, reaching a compromise solution that is difficult to pursue with the use of mono-criteria evaluation methods. A further advantage concerns the influence and the unavoidability of the union between the MCDA and the Geographic Information Systems. This makes possible to evaluate the problem also in spatial terms. In fact, it allows to measure and compare different criteria that distinguish present and future scenarios, substantial key to the urban planning. The work carried out is a first hypothesis for new methods to develop within the planning of our cities, setting the foundation for an increasingly participatory, transparent and sustainable urban science.

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http://www.agenziademanio.it; http://www.isprambiente.gov.it

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Anna Maria Miracco, since 2012 she collaborates with the Pisan associations on the themes of regeneration of the abandoned places of the city of Pisa, organizing exhibitions, conferences and publishing articles on the topic. She graduated in February 2018 with a vote of 110/110 cum laude with a thesis entitled "Urban Regeneration: application of the Multi Criteria Space Analysis for the redevelopment of military barracks in the historic center of Pisa". She currently works with a construction company and with local associations on self-recovery and redevelopment of disused places.

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OPPORTUNITIES FOR THE USE OF COLLABORATIVE 3D MAPPING IN POST DISASTER SITUATIONS

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ABSTRACT

The rising incidence of disasters, the call for community participation in planning and the widespread diffusion of technology, have recently posed a number of new challenges and opportunities in mapping for disaster response and recovery. Expectations are generally higher than in past times, urban settlements tend to become increasingly complex, and collaborative platforms and apps have started to appear as a bottom-up response to the issue of data accessibility. To promptly assess and monitor post-disaster situations and plan for contexts susceptible to worse damage in the event of aftershocks, many research projects have recently tackled the issue of the quick delivery of cartographies though fit-for-purpose automated mapping procedures. Rapid mapping seems, in most cases, to be bind to the use of satellite imagery. Indubitably, satellite data are an invaluable source of broad scale information along the entire disaster management cycle. However, weather conditions may prevent the images acquisition; damage of the buildings facades cannot be directly perceived; if the elements to map are too small problems of data reliability and accuracy arise; 3D information are limited and update frequency might be insufficient. Given the demand for the continuous enhancement of current mapping products, this paper aims at highlighting novel occasions for the complementary use of photogrammetry as a means to collaboratively enrich remotely sensed information through the processing of street-level imagery collected by people, using smartphones. This may help the planner when, under certain circumstances, spatial data were either unavailable, too poor or excessively delayed.

KEYWORDS

3D Collaborative Mapping; Post-Disaster Planning; Crowdsourced Data Collection; Photogrammetry; Open Data

1 INTRODUCTION

During all phases of Disaster Management (DM), from disaster prevention up to post-disaster reconstruction, mapping and spatial data services are essential to assess the needs of people and inform planning decisions. However, the way and the scope for the use of such data varies a lot according to the demands of the different phases in the DM cycle. Before a disaster strikes, the data are used to identify vulnerabilities in the urban configuration and infrastructure; propose solutions to mitigate potential damages; develop operational plans and project scenarios. In the aftermath of a disaster, they support real-time situation and damage assessment (size of the impacted area, intensity of damage, location of victims, access to infrastructure etc.) and later recovery planning, monitoring and change detection, which becomes fundamental where further losses in the event of aftershocks, are expected. In such emergency contexts, it is critical to collect the relevant geo-spatial data quickly. However, information also need to be of the highest possible quality and strictly up-to-date. Therefore, research projects have tackled the issue of their prompt delivery (Baltsavias et al., 2013; Hein et al., 2017) and serious concerns are emerging with regards to efficiency in data acquisition and processing (Toschi et al., 2017). To date, research on rapid mapping procedures seems mainly bind to the elaboration of space and airborne imagery as they remain the main source of broad to medium scale information. High-resolution satellite images currently represent the main information source for rescuers and planners as they come with a rare combination of acceptable spatial resolution (from 30m up to as little as 0.5m), fair update frequency (a few days), and source reliability. Despite these unique capacities, the use of such imagery comes with some limitations. Among others, the Copernicus Emergency Management Service (Copernicus Observer, 2017) highlights three issues: weather-related factors such as cloudiness and atmospheric haze may prevent its effective usage; damage of the buildings facades cannot be directly perceived; if the elements being examined are too small, issues of accuracy may arise. In an attempt to deal with these issues, in 2016 the Copernicus conducted a pilot study in the areas affected by the Central Italy earthquake and tested the potential of deploying manned and Unmanned Aerial Systems (UAS) for the acquisition of a complementary image dataset in support of emergency management actors. The combination of satellite images with other data sources has been suggested in the literature (Casagli et al., 2017) as a way to provide higher spatial detail, better time resolution and mitigate weather–related problems. Ground surveys and visual inspections are still widely used by engineers to inform citizens about whether their homes are safe or by conservation architects when cultural heritage is concerned. In some instances, planners require ground-level information to select the locations for emergency housing camps or to study new mobility routes, but it's when they are required to work at the micro scale (e.g. to design small temporary housing settlements) that they become crucial. Besides, disasters may hit relatively isolated areas in poorly connected territories, previously mapped only at a regional scale as in the Italian case, where the aftershocks had unleashed waves of destruction over a very large rural area, dotted with remote villages, in many cases accessible via only one or two roads due to the complicated topography of the Apennine mountains.

This paper aims to highlight novel opportunities for the complementary use of photogrammetry as a tool to undergo street-level surveys both at the building and at the urban scale. Point clouds can be used as part of a Scan-to-BIM process whereas 3D models from photogrammetry to retrieve updated measurements. The proposed method relies heavily on crowdsourcing as a way to collaboratively collect image sequences captured by people on site. A similar collaborative approach to the use of photogrammetry has recently been tested by Poiesi et al. (2017) giving promising results. The authors have tested the effectiveness of the

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proposed technique to work in post-disaster situations on an image database built by the local population in Central Italy. The results include the 3D models of a portion of Norcia's historic urban walls and of a construction site in Arquata del Tronto. The work is meant to add to the current debate on the integration of alternative data sources for rapid mapping purposes by favouring the perspective of the architect\engineer\planner called to work at the micro-scale, where accurate 3D information are needed. Strengths and limitations for the use of the proposed method are discussed at the end.

2 METHODOLOGY

In order to derive 3D information from a series of 2D image sequences we made use of a photogrammetric range imaging technique known as Structure from Motion (SfM). SfM is a low-cost and user-friendly technique for obtaining high-resolution models at a range of scales; the main advantage being that SfM enables to simultaneously calculate the camera position while solving the scene geometry in an automated, reliable and relatively quick, way (Westoby et al., 2012). This technique can be applied to image datasets collected by common people moving in a space by using just a smartphone or an action camera. The final result is a 3D reconstruction of the captured scene, which maintains the proportions between the objects. However, as the reconstruction is scale-invariant, the knowledge of at least one measure is required to scale the 3D model to its actual dimensions.

This method (Figure 1) enables the derivation of a scaled texturized 3D model from 2D pictures by applying SfM processing techniques to image sequences available online through the following five steps:

- image crowdsourcing\data gathering;
- image grouping, selection and pre-processing;
- image alignment (bundle adjustment) and dense 3d point cloud generation;
- 3D point cloud scaling;
- mesh construction (3D model).

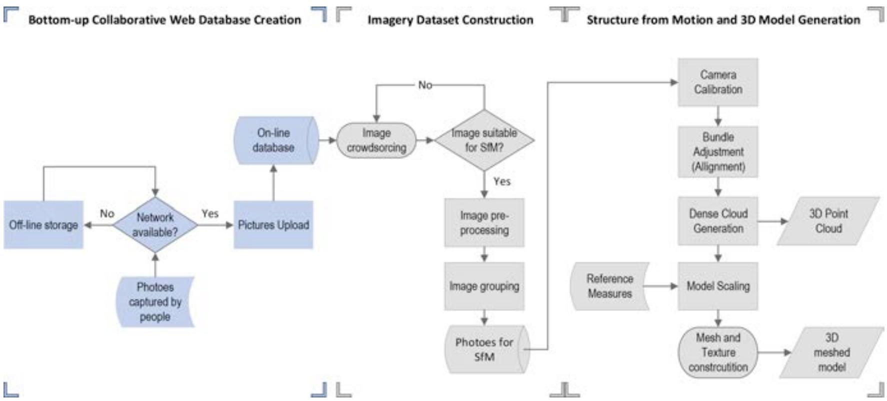

Fig. 1 Flow chart of the collaborative digital workflow; shapes follow the convention of ©Microsoft Visio

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3 DETAILED METHODS AND THE PILOT STUDY

3.1 IMAGE CROWDSOURCING

A good resource for data gathering is Mapillary, which is an open[1] collaborative platform for extracting mapping data in scale using Computer Vision. Mapillary's images are geotagged (have associated GPS information), so they can be visualised in ordered sequences on a web map. Also, they are clustered in time-referenced groups uploaded by different contributors, which enables a fast automatic sequence download. Photos do not have associated metadata (EXIF files), but there is an option to retrieve them if required by the SfM. In the pilot study the images have been entirely collected from Mapillary as the administrator of *Terremoto Centro Italia*[2] (Terremoto Centro Italia, 2016) invited the earthquake-affected people to upload their photos on the platform; stressing the need for post-disaster storytelling and visual descriptions of the many small villages and routes usually rather ignored or underexplored by global mapping services. Additionally, the post highlighted possibilities for users to computationally extract useful information from the images that can be then mapped into OpenStreetMap (OSM) or used for change detection and monitoring. It also mentions the possibility to derive 3D reconstructions from photos by means of a tool called OpenSfM (Gargallo, 2016).

3.2 IMAGE SELECTION, PRE-PROCESSING AND GROUPING

SfM's operative capacity depends on a redundant bundle adjustment based on matching features in many overlapping, offset images. This requires the images to have enough overlap (~20%) and to contain stereo-pairs with sufficient image sharpness (quality ≥ 0,5 in ©Photoscan). A good image pre-selection prevents to process groups that would either fail alignment or be likely to generate inaccuracies in the final model. It may also be necessary to check images' exposure and act upon it beforehand, in case they present abrupt lighting variations. Whenever pictures are poorly exposed, it is recommended to shift their histogram accordingly.

In the pilot study, these tasks have been performed in a supervised way, but there may be scope for this to be automated. In the end, the authors selected and prepared two groups of images: 21 photos portraying severe damages in Norcia's historic walls; and 68 pictures of a temporary housing site in Arquata del Tronto.

3.3 IMAGE ALIGNMENT AND 3D POINT CLOUD GENERATION – SFM

Before proceeding with the bundle adjustment the SfM program requires to calibrate the cameras as distortions can affect the results. This involves identifying the types of lenses used to capture the pictures to be processed. Next, some noisy elements such as cars or people may need to be masked to avoid their processing. After choosing the maximum number of key points (feature points) that ©Photoscan uses to reconstruct the sparse point cloud, images are automatically aligned. Next, it generates the 3D dense cloud,

[1] LCC BY-SA (Creative Commons Attribution–Share Alike License) grants four freedoms: use and perform the work; study the work and apply the information; redistribute copies; and distribute derivative works. It comes with some key restrictions: to give proper attribution to the author and release derivative works under an identical or similar license, without the possibility of restricting access to the work.

[2] Terremoto Centro Italia is also a collaborative Platform, born as a bottom-up response to allow better community collaboration after the Italian earthquake (Terremoto Centro Italia, n.d.)

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whose pre-set accuracy (from low to ultra-high) must be chosen according to the actual needs of the professional who is intentioned to use the final model, as it affects processing time.
In the pilot study, a fisheye calibration was used for Norcia, where pictures had been captured with an action camera. In Arquata's sequence the calibration was kept on frame, as the photos were made with standard lenses. Because Norcia's historic walls were well texturized, less tie points were used to align the images. For Arquata del Tronto this was not the case and more points and a mild depth filtering setting were required to reconstruct the scene in 3D. The adopted parameters are reported in table 1.

VARIABLES	NORCIA	ARQUATA DEL TRONTO
Number of pictures	21	68
Images resolution (pixels)	20148 x 1536	2048 x 1152
Mapillary user and date of upload	Kymolos _ 13\12\2016	Chiccap _ 29\04\2016
Camera Calibration	Fisheye	Frame
Key and Tie point limit	40000, 2000	0, 0
Bundle Adjustment (min)	0,91	19,710
Filtering type	Aggressive	Mild
Dense Cloud Accuracy	Ultra High	Ultra High
Number of points	4.712.160	2.335.922
Dense Cloud generation (min)	3,24	46,045

Tab. 1 SfM processing times and settings for the two case studies

3.4 3D MODEL SCALING

The 3D point cloud generated by the SfM algorithm needs to be scaled appropriately before it can be used to derive plans, sections, elevations, or any other metric information. Scaling requires referencing, which can be done either on the 3D point cloud or on the meshed object. The first option is to prefer when the intention is to create a BIM or HBIM model by using the point cloud as a geometric reference. Opportunities for similar applications at the Urban level are explored in (Courtney et al., 2017).
In this pilot study, we decided to scale the point cloud (Figure 2) as this tends to produce more accurate results. In Norcia's case the OSM cartography was downloaded from the internet and the footprint of a bastion was used as a reference for this task; Arquata's point cloud was scaled in a similar way.

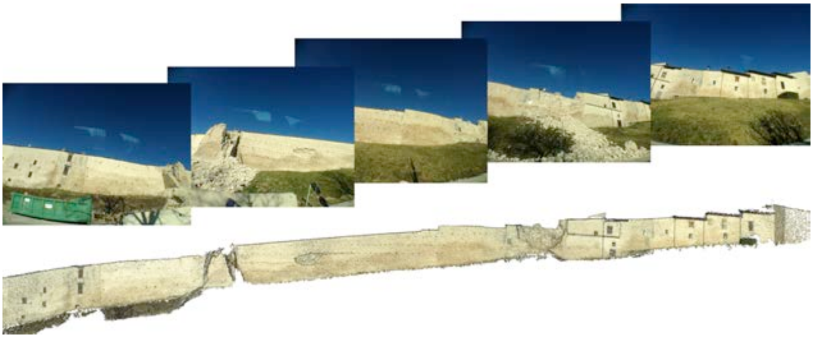

Fig. 2 Frames of Norcia's image sequence and 3D point cloud frontal view

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3.5 MESH CONSTRUCTION

The final step is the construction of the texturized 3D model, which can be a reference for problem visualisation and project communication. ©Photoscan has an internal tool to perform this task, which allows to choose between a geometry generation optimised either for terrain or 3D object modelling. However, it may still be necessary to adjust geometry topological errors or to decrease the mesh complexity. Figure 3 provides an illustration of Arquata's 3D model before post-processing.

To sum up, table 2 shows how long it took to complete each of the 5 steps described this section for the pilot study. The time for completion was relatively short, in the order of minutes, with a maximum total of 90 minutes[3].

TASK-SPECIFIC DURATION (min)	NORCIA	ARQUATA DEL TRONTO
Step 1 : image download (crowdsourcing)	~1	~2
Step 2 : image selection, pre-processing and grouping	~5	~10
Step 3 : structure from motion	4,15	65,76
Step 4 : 3D model scaling	~ 8	~ 10
Step 5 : mesh construction	5,82	2,93
Total processing time	~24	~90

Tab. 2 Processing time breakdown

4 DISCUSSION

Because nearly all information that is possible to access remotely in a short time can be valuable to decision-makers, SfM holds potential for offering a worthy additional support to the other surveying techniques used in disaster management. The proposed collaborative digital workflow represents an opportunity to complement data collected by satellites with 3D models. However, further studies on rapid "multi-scale" mapping are still required to integrate the use of crowdsourced street-level imagery in an automated workflow.

A clear limitation of the proposed method is that remote communication is likely to be affected in the hours following a disaster by disruptions in the network. However, some rescue teams are equipped with powerful and portable telecommunication systems for the provision of a better group-effort coordination, as for example the Italian Civil Protection body. Alternatively, pictures may be stored locally and uploaded at a later time.

Further limits concern the absence of guidelines for collaborative data generation in post-disaster situations.

For instance, many of the datasets downloaded for this study had insufficient overlapping area or image quality and presented objects that did not fully occupy the scene, ultimately causing the impossibility to use many of the images for photogrammetry purposes.

[3] Hardware of the of the laptop used to run the test. CPU: Intel(R) Core(TM) i7-4712HQ, 2.30GHz. RAM: 15,9 GB. GPU: NVIDIA GeForce GT 750M/PCIe/SSE2.

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Fig. 3 Arquata del Tronto case study. From top-down: section of the 3D point cloud; point cloud with aligned photos; meshed model

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MODELS AT THE TIME OF WEAK PLANNING

THEIR ROLE, IF ANY

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ABSTRACT

If the present weak character of planning is generally undisputed, such weakness can be actually observed on several aspects. There is an objective notion of weakness, due to the feeble role planning has actually played in managing the territorial development, with scarce effects on its dynamics. On this regard, planning is said to be weak, as it actually lacks the strength and incisiveness it once was assigned. Another notion of weakness is proposed as resulting from a dialogical vision of planning, often and variously referred to as advocacy planning, equity planning, progressive planning, participatory planning, collaborative planning, community-based planning: a weakness deriving from renouncing to design and realize scenarios, for rather managing the decision process, interacting with citizens and communities. On this last regard, planning is weak as aimed at organizing a process rather than providing a product.
A third kind of weakness could be said programmatic, as deriving from a different role some suggest it ought to play: not to be intended as an oriented action towards a desirable state, but rather as a system of rules aimed at regulating the development of settlements by means of the definition of what can be made and the prohibition of what is excluded. On this second regard, planning is said to be weak, as it is hoped to renounce its traditional assertive and 'strong' role. In light of such variety of meanings, the question of the current role of models as planning support tools should properly be posed with reference to the different meanings of weakness, so as to provide different responses. What is the purpose and the content of the present paper.

KEYWORDS

Urban Models; Urban Planning; Self-Organization; Participatory Planning; Negative Planning

1 INTRODUCTION

It is now generally acknowledged as an oft-repeated expression, almost a platitude, that our times are characterized by a weak role of planning, so that such weakness appears suitable for identifying this long-lasting season of regional and urban planning. As far as models are concerned, it is therefore appropriate and interesting to discuss the role they can actually play within such a framework. In its broadest sense, the weak attitude in planning can be acknowledged as the wide and general consequence of the profound epistemic and cultural changes occurred in the late 20th century (Kuhn, 1970): on the one hand, it embraces the epochal sunset of positivistic trust in the rational-comprehensive values, that is the reliance in the capacity of the rational evaluation and decision making processes to comprehend and direct the individual and collective behavior, so as to plan the organization and development of settlements; on the other hand, it also involves the arising of the wide paradigm that goes under the term of 'complexity science', which acknowledges the system dynamics as the uncertain outcome of feedback mechanisms - unpredictable and non-linear – as well as the result of self-organization phenomena. In the transfer from the scarcity society to the risk society (Chernomas, 1984), a deterministic view, based on certainty and linearity, is replaced by a condition of global uncertainty (Beck, 2000). Such uncertainty actually undermines any possible anticipation or prefiguration of scenarios to come, not to say the reliability of any aspiration or pretension to shape them: what precisely should be the purpose and sense of planning, which therefore can only result intrinsically weak. Yet, if we go beyond the general sense of unpredictability that derives from the fall of rational certainty, if we more specifically look into the often discussed question of weak planning, here things get more varied, showing different forms of weakness.

2 WHICH WEAKNESS

In the last years the claimed weakness of urban planning has been so recurring as to become an "umbrella term", suitable for covering different meanings and supporting different purposes: closing that umbrella and exposing the several meaning it covers will be here assumed a preliminary task in order to discuss the role models can actually play as a planning support.

An objective notion of weakness has been for years tangible and widely denounced: our times are undoubtedly characterized by a feeble role of planning, which, as a matter of fact, appears scarcely influential on the territorial dynamics that on paper it should be expected to manage. Since the late '70s, when town plans were regarded as fixed and unquestionable landmarks, prominent interventions and great urban transformations have often occurred setting them aside, when not even plainly disregarding their provisions.

The plan themselves, once prescriptive guidelines and mandatory shapers of territorial scenarios, have become just feeble regulatory references, easily amendable and widely editable according to agreements or incidental occurrences. Starting from the critique of the plan as an impediment to initiative and enterprises, the role of planning has gone becoming more and more subordinated to the economic instances. At the same time, fought under different vessels and emphasized by recurring passwords such as deregulation, streamlining, simplifying, facilitating, the battle against the authoritative plan and the rational-comprehensive principle of the cascaded procedural system of Law 1150/1942 has gone demolishing the idea that the urban development should comply with (and tend to) a prearranged pattern and design, or at least to correspond a general shared framework; what has deprived urban planning of most of its actual

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strength. Planning is hence weak, as it actually lacks the strength and incisiveness it once was plainly credited with. Another meaning of weakness results from a dialogical vision of planning, arising from the "*transizione dalle ipotesi fondative dell'urbanistica come forma di razionalità forte a forme argomentative più vicine alle dimensioni etiche e ai requisiti della disciplina come scienza sociale applicata*" (Maciocco, 1995): different planning approaches, which have been variously named and referred to as advocacy planning, equity planning, progressive planning, participatory planning, collaborative planning, community-based planning: all those approaches appear sharing the strategic role of communication and information, which are assumed as a decisive source of power in the decision making process.

In such a view, planning is weak in that it does not prefigure scenarios resulting from choices, nor it provides design solutions: it only manages the decision process in a context of dialogical interaction and debate with citizens and communities: "*progressive planning (…) is at once a democratizing and a practical organizing process*" (Forester, 1989). Shortly, planning is weak in that it is aimed at organizing a process rather than at providing a (spatial or functional) product: it '*consists of the elements of envisioning a problem situation, managing arguments concerning it, and negotiating strategically to intervene*' (Forester, 1989). A further notion of planning weakness, which appears increasingly widespread and shared over time, could be said programmatic, as it derives from the recommendation of a completely different role of planning, resulting from the epistemic change that was mentioned above.

Juval Portugali identifies such a radical change of paradigm as the first dilemma with planning: '*It became evident that 'rational comprehensive planning' (...) is an irrational assumption, that planning is a political, incremental (...) and essentially 'non-scientific' and non-technical process; it became apparent that (...) the spectacular scientific instruments we've developed fail to tame the city, the metropolis, the megalopolis, the environment (...), that beautiful scientific instruments such as the gravity, interaction, or entropy maximization models (...) can hardly scratch the complexity of the urban scenario*' (Portugali, 2000). The continuity of the rational process going from knowledge to action – anchored in the words of Auguste Comte '*science, d'où prévoyance; prévoyance, d'où action*' - seems to break. No longer planning can be intended as an oriented action towards a desirable state; no longer the term 'planning' is acknowledged in its literal meaning, that is 'making plans', or shaping a scenario to be realized. The aim is then to solve the lexical chunk of planning as a predictive/prescriptive action, assuming a weak way of planning (a planless planning) in place of a strong (assertive) role.

A possible '*planless planning*' can be provided by the shift from a teleological vision – targeted to achieve a prefigured arrangement – to a nomological approach - aimed at defining a system of general and abstract rules: this, which was also called 'urban code', can be a set of qualitative guidelines concerning buildings shape and location (Alfasi & Portugali, 2007) or, differently, a set of abstract and generic rules, aimed at regulating the development of settlements defining what can be made by means of the prohibition of what is excluded (Moroni, 2007; Moroni, 2013).

Such view embodies the 'negative role' that Blečić and Cecchini suggest as an essential requirement of robustness and antifragility of planning: negative planning as intended to explicitly state what cannot be done (of soil, of areas, of buildings), in place of the traditional 'positive', assertive role of planning, suitable for defining a target and the path to reach it (Blečić & Cecchini, 2016).

As a matter of fact, this is not an unprecedented view: in the second half of the XIX century, several town plans were limited to merely defining the infrastructural skeleton of the settlement, leaving wide and undetermined the areas inside this major grid to be shaped for housing, available for the location of any kind of activities, according to the '*sviluppo che prenderà la fabbricazione nell'una o nell'altra parte della città'* and

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the *'probabili innovazioni che saranno per emergere dal presente stato di transizione dell'arte edilizia* (Boriani et al., 1992); in fact the Beruto Plan of Milan, in its first version of 1863 - which for the same reason was denied the requested acknowledgement of 'public usefulness' by the Ministero dei Lavori Pubblici -, may well be taken as an example of such approach (Boriani et al., 1992). Not new then, such a weak role of planning has been re-emerging in these last decades, as a consequence of the arising crisis of the urban masterplan as well as a possible way to overcome its criticalities.

Beside the division of the masterplan into three different phases (structural, operational and regulatory) – as proposed in 1995 in the XXI INU conference, and variously accepted and applied in several Italian regions – and its disempowerment by means of a widespread deregulation, a weak way of planning, intended to abandon a teleological vision for a nomocratic approach – and the plan itself for a set of abstract and generic rules – has gone gaining an increasing consensus in the recent years. If a nomocratic view of planning actually appears capable to overcome the problems of inefficacy, inefficiency and iniquity the masterplan was imputed of, yet a couple of questions seems to arise.

First, a methodologic matter: a nomocratic approach, as merely aimed at regulating individual actions and behavior, setting aside the making of a targeted state, assumed as desirable, involves a non-consequentialist position, so as to disregard the effects of such actions. Yet, some authors notice that a regulatory way of planning does anyhow involves precise and concrete effects on the inner geography of settlements: *'history shows that the effect of rules on pattern, use and form has not been trivial'* (Talen, 2012); and those effects, far less visible than in traditional planning, cannot but be thoroughly regarded. Not to talk of the relevant effects that a traditional (and unavoidable) way of planning infrastructures and public facilities obviously involves (Moroni, 2013), which cannot but deform and preconditioning the playfield of individual actions and behaviours: which, on the contrary, ought to be neutral and objective. What imposes to re-assume a consequentialist approach, in order to appraise and evaluate such effects with reference to some targeted state: a teleological position, radically excluded by the nomocratic approach, appears re-entering through the window, due to the effects of both abstract rules and infrastructural planning.

Second, a matter of efficiency: the individual actions, if freed from assertive planning prescriptions and merely regulated by abstract and general rules, are uniquely subjected to the mechanisms of free housing market; but is market actually capable to provide an efficient resources location? On such point, the presence of externalities and public goods poses some crucial questions (Camagni, 2008): how can housing market avoid (or mitigate) the negative effects caused by the individual actions to anyone not involved in decision making processes, namely private citizens, the whole community or even the future generations? And, how can building and real estate market substitute the traditional (and public) planning of public goods, which, as non-excludible goods, can't be actually priced? Such questions are still open as a subject of heated debate. As it is wide open the matter of the role urban models can play as planning support tools, with reference to the distinct senses of weakness that planning is actually expressing.

3 WHICH ROLE, IF ANY

The trust on the reliability of models and on their effectiveness to reproduce the reality and its dynamics could only be demolished by the radical epistemic change mentioned above: the implicit (and unjustified) associated of quantitative and scientific models with rational-comprehensive approach has made the first rejected with the second, and the baby thrown out with the bathwater.

Seeking to recover the baby out of the water, it should conversely be noted that not all the territorial analysis models are based on a deterministic approach; since the early '70 stochastic elements were

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introduced as an improvement of classic models: among them, some relevant studies by Jay Forrester on the non-linear growth dynamics, a probabilistic version of spatial interaction models by Wilson, dynamic and non-linear approaches by Leonardi, Lombardo and Rabino, the first researches of Peter Allen on self-organization processes.

A wide variety of modelling approaches focusing on self-organizing phenomena according to a probabilistic vision has then emerged in the last decades: multiagent systems, cellular automata, boolean networks, SOUDY models, SLEUTH models, *swarm intelligence*, *ant algorithms* – among the others – appear sharing their point of view within the observed phenomenon, the focus on bottom-up processes, non-linear relations, co-evolution and self-organization dynamics.

Furthermore, we can mention the methods that focus on network processes and topological relationships, such as neural networks, Bayesian networks, complex network, small-world networks, space syntax; as well as the use of advanced statistical techniques for the treatment and modelling of data, such as genetic algorithms, data mining, multidimensional scaling and geostatistical and geoprocessing techniques. Materializing an increasing interest in the morphogenetic processes, several research lines have recently gone focusing on the dynamic modelling of urban form: among them, in particular, the spatial analysis, the configurational analysis, the analysis of fractal geometry, the Allen-Sanglier model; and an increasing interest seems to regard the qualitative models of urban space, such as the urban simulation models, the FACS models and the cognitive maps.

All these methods are mentioned to point out that in the era of complexity and uncertainty, well after the epistemic revolution of the last century, a wide range of models, often worked out or made actually feasible by the advances in informatics, has composed a vital toolbox for territorial knowledge; models that share a different approach from the one prevailing in the previous decades, in that they:

- abandon a deterministic logic and present a new attention to the issues of complexity;
- overcome the two-way relationship between model and reality, which they renounce to reproduce in a unique construction;
- are rather proposed as a partial and limited conceptual construction, oriented towards the understanding of single aspects, so that different models may coexist at different scales – one next to the other;
- are frugal, simple and flexible (Cecchini, 1999);
- renounce a rational-comprehensive approach, aimed at validating a vertical decision making process, to work as a tool for understanding and orienting local-scale emergent phenomena, in order to manage self-organization processes;
- on the whole, renounce the pretension to embody a unique and all-encompassing ideological vision, opening towards different possible views.

Even if with different features, urban models are hence still fresh and alive after the epistemic storm of the late 20th century. It remains to be seen if they can still play a role in the present age of weak planning. Apparently, if we assume weakness as feebleness, and planning as poorly influent on urban dynamics and development, we can’t but recognize that models – as a support tool of decision making process - actually lose their very raison d’être; only, they maintain some general usefulness as a tool for merely describing and interpreting urban contexts; or, mainly at an infra-urban scale, for supporting transparent negotiation processes.

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- Nonetheless, it’s worth highlighting the role that several models based on a probabilistic vision can play in activating the regeneration of urban deteriorated areas, so as to orient bottom-up processes and manage locally self-organized urban dynamics (cutini, 2018).

Also an assumption of weakness as wide-openness to dialog and negotiation, regarding planning as focusing on the participatory process and does not providing any ‘product’ to assess and validate, cannot but imply a reduced usefulness of models.

- Nonetheless, models remain undoubtedly useful for enriching the information at our disposal, thanks to their capacity to extract knowledge, to construct scenarios, to simulate effects and phenomena: ‘*planners (…) can support citizens victimized by an unequal distribution of resources; they can help organize social movements and provide them much needed information and expertise; and they can share with people their understanding of structural factors in urban development.’* (Fischler, 1989).

  In order to empower, enhance and diffuse information, it is important to point out prospects offered by the informatics, which were recorded as participatory e-planning (Saad-Sulonen, 2012): by means of web-GIS advanced toolboxes and on-line platforms (such as Plans-on-the-map, Tell-it-on-the-map, Peer-To-Peer Planning), they admittedly allow a more active, capillary and organized participation in the decision making process.

At a first glance, the role of models is apparently negligible also assuming weakness as unassertiveness, that is regarding planning according to a nomocratic vision: the abandonment of a teleological approach involves a non-consequentialist vision, which excludes at the roots the need to assess (by means of models) the predictable effects of a planned state, which just does not exist.

- Nonetheless, any code of abstract and general rules must necessarily be accompanied by some specific prescriptions, concerning in particular the streets grid, the location of plants, infrastructures and public facilities, thus subjected to ‘positive’ planning (Moroni, 2013): and, as it was discussed above, models come into play as a necessary tool for investigating their effects on the presumed neutral playfield of individual actions.

  Similarly, models are called into play in order to investigate the consequence on urban geography and form of abstract codes of abstract and generic rules: ‘*une connaissance urbaine est toujours injectée dans l’urbanisme des règles. Cette connaissance peut nous venir de l’analyse phénoménologique de l’histoire urbaine, ou bien de modélisation à base de règles implementable aujourd’hui sur un support informatique*’ (Fusco, 2018).

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INFORMAL SETTLEMENTS, COMPLEXITY AND URBAN MODELS

IS THERE ANY ORDER IN AUTOPOIETIC URBAN SYSTEMS?

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ABSTRACT

In 1961, Jane Jacobs depicted the city as a problem of organized complexity, endowed of inner unpredictability. Urban planning tools are expected to reflect this nature of the city, what is not that obvious. The sunset of the golden age of urban modelling, based on a rational comprehensive approach, has revealed the difficulties in pursuing such purpose according to a deterministic logic, thus opening the way to a stochastic approach, under the idea that unpredictable elements and random variables deeply affect the city functioning. In this broad framework, the configurational analysis of urban space, first pioneered by Bill Hillier, has gained momentum, assuming the urban grid as the primary element in the phenomena that occur within the city and in the urban dynamics as well. In so doing, it has brought to light key underlying structures in the city, showing that also autopoietic urban systems seem to materialize the equilibrium between environmental, economic and socio-cultural forces. Informal settlements appear an ideal testing field of the configurational approach. Fostering the idea that informal communities actually drive the evolution of such settlements, this paper aims at using the configurational analysis to make their hidden order to emerge, in order to face the matter of the upgrading of these "forgotten places", overtaking the idea of an impossible removal. The Baseco Compound, in the center of the mega-city of Metro-Manila, hosting no less than 90,000 people in an area of about 0.6 square kilometers and doubled in size over the last 15 years, appears an ideal case study to implement the configurational techniques in order to reveal and identify an order and a spatial logic where order and logic are supposed not to be.

KEYWORDS

People with Autism; Quality of Urban Life; Urban Capabilities

1 INTRODUCTION: OR, RATHER, THE UNDERLYING ORDER OF AUTOPOIETIC URBAN SYSTEMS

Informal settlements represent one of the most widespread and critical urban issues in the present global scenario. The Habitat agency of United Nations defines informal settlements as residential areas where inhabitants have no security of tenure dwellings they inhabit, with modalities ranging from squatting to informal rental housing, the neighbourhoods usually lack, or are segregated from, basic services and city infrastructure and the housing do not comply with current planning and building regulations. Furthermore, informal settlements are often situated in geographically and environmentally hazardous areas and, as a consequence of their intrinsic socio-economic features, their inhabitants are constantly exposed to eviction, disease and violence (UN-Habitat, 2015). Such a definition involves a perimeter that, as a matter of fact, currently includes more than 25% world population, having increased around 213 million people in the last 25 years (UN-Habitat, 2013). As is clear, it represents anything but a small geographic area, since its features can be widely recognized within a large part of Africa, in Asia, Latin America, and in some cases in the developed countries and in Italy as well. Due to their specific features, it is not easy to ascribe the layout of informal settlements to schemes, patterns or formal archetypes; and it is also hard to use methods for supporting the management of urban parts that seem to refuse any management and planning rule. The absence of pattern, the intrinsic incoherence of forms, the lacking of infrastructures, the uncertain definition of public and private spaces, the precariousness of the located activities and the vagueness in land use: all this makes the analysis tools blunt instruments, which can hardly be used in a labile field, where housing and activities location have been increasing in a total absence of rules. A different analysis approach is therefore required, so as to focus on the actual spatial forms, and to recognize within them the (social, cultural, functional) elements that have determined their genesis; the elements that presently remain implicitly embodied within the spatial organization of the settlements and are their intrinsic founding principles as well as their vital sense. The idea is that a subtle, intrinsic order exist in urban areas that are apparently devoid of order; an invisible order, hidden behind the casual arrangement of buildings and the chaotic texture they form; an order that is the result of a autopoietic process, carried out by the community in order to adapt their spatial behaviour (their movement, their activities location, their housing, their inner geography of their neighbourhoods) to their cultural roots and social and cultural organization; an order, whose features cannot be found in the material appearances of the neighborhoods, in the shape of blocks, buildings, streets and squares, but in the relational state of the urban grid. This is what makes the configurational techniques, which are expressly based on the role of the urban grid as the primary element of the phenomena that occur within its paths, a powerful toolbox for identifying such order, making it to emerge and defining its features. It will be argued that the use of a configurational approach can allow detecting the self-organization processes that govern the bottom-up dynamics which materialize into the informal settlements. It will also provide considerations for policies and strategies aimed at upgrading those areas and improving their environmental condition.

2 BACKGROUND: INFORMAL COMPLEXITY AND CONFIGURATIONAL ANALYSIS

A city, although in some cases apparently ordered, as characterized by a recognizable geometric form or pattern, is undoubtedly a complex system. Behind a physical structure, materially made up of buildings, blocks, streets and squares - or more generally of free access places - an intricate system of reciprocally

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connected phenomena takes place in the city: what induces to make an actual duality to arise: on one side, a large collection of buildings connected by space; on the other one, a rich set of activities linked by interactions (Vaughan, 2007). The long-lasting debate on whether these two dimensions are connected is the foundation of the configurational approach of Space Syntax, since the relationship between physical and social layer in the city symbolize the link between structural and functional spatial features (Hillier, 2012). In the aim of developing a "unique" theory of the city as a whole, Space Syntax approach assumes that the urban space is "the common ground for physical and societal cities" (Vaughan, 2007). The freely accessible space of the city, as the place where urban phenomena happen, is considered to be a spatial configuration, or rather a set of "relations between all various spaces of a system" (Vaughan, 2007). A network of interconnected open spaces could hence represent the urban layout. It is what we call an urban grid, whose elements contribute to the functioning of the city. The grid configuration in itself generates and affects movement rates. The theory of the so-called natural movement - that is the portion of movement that does not depend on the located activities, but only in the grid configuration (Hillier et al., 1993) - assigns the space a generative role on urban phenomena, as primarily influenced by the whole grid. Space Syntax assumes that activities located on the grid can amplify the movement rate induced by the spatial configuration, acting as movement's multipliers. We call them configurational attractors. As opposite, non-configurational attractors generate movement rates regardless of the grid, as it is the case of monopolistic urban activities. Following the so-called "movement economy" process (Hillier et al., 1993), both kind of attractors contribute to define the movement rates underlying city functioning: the space, directly influencing movement, generates human interaction bringing social and cultural pattern into the urban layout. Form and function of urban space are related by a non-casual connection, due to the strong influence of urban layout on space potential (Hillier 1996; Vaughan 2007). Space Syntax theorizes that spatial configuration, depending on the purely topological structure of the urban grid, is fully expresses by the dual graph that is gotten by switching the edge of the urban network into the nodes of the graph and, conversely, nodes in edges. In this manner, several measures of centrality can be identified on the urban graph. The Space Syntax techniques, in fact, provide each element of a spatial grid with a full set of numeric values that correspond to several configurational parameters; yet the notion of centrality – appraised in terms of attractiveness for activities - is actually pivoted around two measures known as "choice" and "integration". The first one (betweenness in graph theory) expresses how many chances has a node to intercept flows on the graph. The second one (closeness in graph theory) expresses how close a node is to all the others on the graph.

According to Freeman (1978), betweenness measure C_B for a point P_i is concretely obtained comparing the number of geodesic paths between P_j and P_k containing P_i ($g_{jk}(P_i)$, where i ≠ j, ≠ k; j < k) with the total number of geodesic paths linking P_j and P_k (g_{jk}) (Freeman, 1978; Hillier & Iida, 2005). Defining n the total number of nodes in a graph, choice index can be obtained as

$$C_B(P_i)=\sum_{j}^{n}\sum_{k}^{n}\frac{g_{jk}(P_i)}{g_{jk}}$$

Several researches so far have certified choice value as a reliable index in the estimation of movements rates in the city, especially when applied to determine the distribution of vehicular movement flows. According to Sabidussi (1966), the closeness measure C_C of a point P_i can be obtained considering the inverse of the total

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number of edges in the geodesic path between the points P_i and P_j ($d(P_i,P_j)$) (Freeman, 1978; Hillier & Iida, 2005; Sabidussi, 1966):

$$C_C(P_i)=\left[\sum_j d(P_i,P_j)\right]^{-1}$$

Integration value is the most important measure in configurational analysis, assuring a reliable correlation with the distribution of movement flows, mainly pedestrian, and the density of located activities; the parts of the urban grid that results provided with higher integration values is acknowledged as its integration core. Integration is able to make the urban structure to arise. The process of network generation, as previously introduced, allows to give a spatial meaning to the topological measures of centrality, so that we can easily switch from nodes of the graph to lines in the space, characterizing space with the topological properties of the associated urban graph. The results of network analysis could hence be pushed onto reality. Configurational indexes express different properties of the city depending on the scale of analysis. At local scale, restricting the analysis to a defined number of nodes/lines around a given node/line, they reflect the way humans cognize the spatial reality; at global scale, analyzing the system as a whole, the give a non-discursive description of the urban structure. Several studies so far proved the existence of a direct and narrow relationship between configurational indexes and movement rate, making the configurational approach a reliable tool for investigating the working of urban environments and making hidden properties of a settlement to arise. Such an approach could be effectively used to investigate whether – and to which extent - informal and autopoietic urban structures are actually provided with an inner order, which remains intrinsically materialized within its grid and cannot be identified by means of a traditional geometric approach. It operates, in facts, basing on the topology a spatial settlement expresses instead of the geometry it shows, changing the meaning of "structure" in itself. While recognizing that some geometrical structures show an intuitive relation to specific topological configurations - Hippodamian structures in particular, considered paradigmatic in movement efficiency since ancient times - it is not obvious that apparently (that is, geometrically) ordered settlements work better than others appearing twisted, less harmonious, or anyway lacking an easily recognizable order, pattern or design. This is the case of informal settlements, whose layout, by definition, generally does not correspond to geometrical schemes, formal patterns or morphologic archetypes.

3 CASE STUDIES: DOES INFORMALITY CONCERN ALSO EUROPE?

This paper presents a research that is based on an inductive approach. It won't investigate the theoretic mechanism of self-organization processes that determines the making of autopoietic settlements. Nor, it won't discuss the specific (geometrical, functional, socio-economical) features of such settlements, which are clearly very different from one case to another, due to their physiological lacking of pattern or regulatory rules. The research will rather focus on the configurational properties, if any, that appear shared by radically different urban cases, which undoubtedly only share their informal settlement, resulting from a self-organized genesis. According to this criterion, our case studies have been selected and drawn out of different geographic contexts, in the so-called developing countries and in the developed ones as well: a comparison of their respective results will only regard their configurational state, setting aside all the differences that distinguish them. Autopoietic settlements are widely spreading throughout the world, especially in areas where strong population growth dynamics induces a wide urban expansion. Often, this type of settlements assumes the characteristics of "informality", generally intended as the extreme form of

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anarchy in the occupation of urban land and in the hoarding of public services. Are developed countries immune to these forms of urban environment? Urban science has no direct and unambiguous answer to this question. While it is difficult to bump into a real informal settlement, there are many densely populated areas where the rules and forms of urbanization actually assume ambiguous characters, even in Asia (Karimi & Parham, 2012) and in the heart of the old continent as well. Focusing on the first case of the informal settlement of the Baseco Compound, in the city center of Manila, the research aims at recognizing similarities with some autopoietic settlements in Europe. Manila is the political and economic center of the Philippines and is one of the major metropolitan regions in Asia-Pacific. The metropolis is the 18th largest urban agglomeration in the world in terms of population size, and according to the World Health Organization, about 35 percent of the capital region's 14 million population live in slums. On the edge of the port of Manila, by the banks of Pasig river, is located an Engineer's Island established in the mid-1950s and informally known as the Baseco Compound. The area has an extension of about 0.6 Km. sq. and a population estimated in more than 70.000 inhabitants (Philippine Statistic Authority, 2017). The lack of a reliable registry makes difficult, if not impossible, to know the actual number of inhabitants, which unofficial reconstructions consider exceeding one hundred thousand units. The territorial and urban morphology of Baseco have largely changed in the last decade, and, due to an uncontrolled building activity, the island is now almost completely occupied (Fig. 1). The result is a very fragmented area, which has few properly structured public spaces and many common spaces, where the boundary of private property is very labile. This obviously reverberates on the conformation of the urban network of the settlement, which in fact show a high average density of lines (about 48,000 lines per Km sq.).

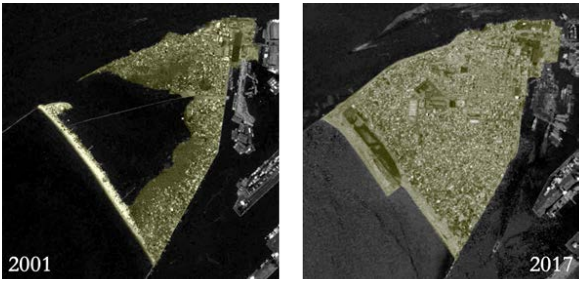

Fig. 1 The evolution of Baseco Compound (2001 – 2017). The emerged land is highlighted in yellow

The configurational analysis of the settlement unveils a strong polarization of the global integration and choice indexes. Both their values are very high in the lines that represent, within urban network, the few existing paved roads (Fig. 2). This highlights the lacking of a real urban center, in favour of an infrastructural framework, mainly devoted to pedestrian and vehicular movement and to the activities directly connected as well (some shops and few services - mainly schools and places of worship), which holds together and connects a large array of highly autonomous local centralities. Their presence is confirmed by the analysis with limited metric radius – the so-called "local analysis" - which highlights a very high fragmentation of the area. Baseco stands out as constituted by many groups of highly autonomous lines (high index of local integration) and small magnitude (less than 200 meters). Such result is clearly shown in the so-called "background patchwork analysis" (Al Sayed et al., 2014), which is a bi-dimensional graph whose lower peaks on the y-axis indicate how many local centralities there are, and the distance of the same peaks along the x-axis stands for their mean mutual distance (Fig. 3).

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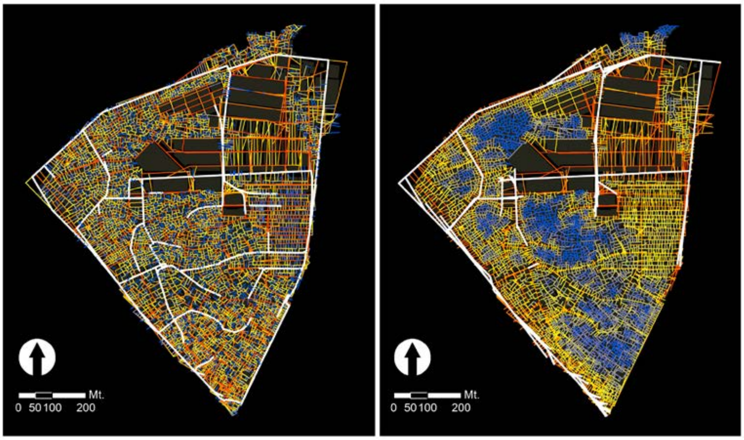

Fig. 2 Configurational analysis of the Baseco Compound: global choice (left) and global integration (right). White lines have higher values

This anomalous urban structure reflects the particular social structure of Baseco, in which life takes place in a community way for small proximal groups, as the evidence in the use of space seems to confirm (Cutini & Di Pinto, 2018). The case of Baseco, although summarily introduced, highlights the close relationship between urban space and local communities: if usually social needs tend to shape the space, in particular conditions the constraints imposed on urban development seem to prevail, determining the adaptation of the community to the existing or possible urban scenario. The balance between these instances determines the actual working of a settlement and leaves a clear trace in its topological framework. Thus, a configurational analysis appears an indispensable tool for revealing the presence and actual working of such a mechanism of mutual adaptation of space and local communities. A case in which a self-organization process clearly prevails and which is no stranger to Europe and to the entire western world, where some considerable examples could be found. Albeit with different forms and with mitigated outcomes, if compared to the informal settlements in developing countries, also the European scenario presents, in fact, autopoietic adaptations of space and urban communities. A paradigmatic case, for the issues it poses and the international echo it holds, is the Vesuvian coastal strip. This area, which has been experiencing an uninterrupted growth process since the 1950s, has undergone a transition that in just a few decades has transformed it from a nuclear urban settlement into an urban continuum that houses about 400,000 people in a strip of land at south of Naples, narrowed between the sea and one of the most dangerous active volcanoes on the planet. As elsewhere described (Cutini & Di Pinto, 2015), the result of this transition is the lowering of the average density of the built space compared to that of the individual pre-existing nuclei, with a consequent increase in the risk of isolation of one or more parts of the urban system and an increase in traffic levels on few critical roads; what also affect the normal functioning of A3 motorway (Di Pinto, 2018). All this translates into an increase of the vulnerability of the Vesuvian coastal settlement to volcanic hazard, as the comparison between the synthetic indexes in synchronic and diachronic scenarios clearly expresses (Fig. 4). The case of the Vesuvius does well reveal the pitfalls that the urban autopoiesis can conceal and, at the same time, highlights the need to consider appropriate approaches, tools, strategies in order to identify, recognize and manage them.

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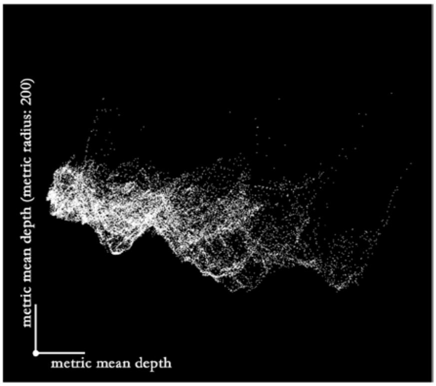

Fig. 3 Configurational analysis of the Baseco Compound: Background Patchwork Analysis (BPA) – local metric radius: 200

5 CONCLUSIONS AND FUTURE DEVELOPMENTS

The findings of the case studies that were briefly presented above can be summarized in the following results. First, radically different informal settlements seem to share some constants configurational properties, which can hence be assumed as clear hints of a recurring order, whose features are not readable in the stones of the material city but embedded within the spatial relationships of its grid. Moreover, despite all the evident differences that distinguish them, still the inner geography of the observed settlements is narrowly connected to the behavioral pattern of the located communities, so as to be recognizable as the output of a process of mutual adaptation of social and material city. Furthermore, not necessarily an autopoietic growth dynamics is suitable for intrinsically assuring a settlement high levels of robustness and resilience; on the contrary, self-organization processes may well involve an increased vulnerability of the system. The configurational analysis of the settlement can reveal such effects; and they can also orient the guidelines for activating regeneration processes, aimed at upgrading the degraded areas and improving their environmental condition. What is not a trivial result, but rather a promising starting point. On such bases, developments can be expected from further researches on the mechanisms of urban addition and growth governed by self-organization processes.

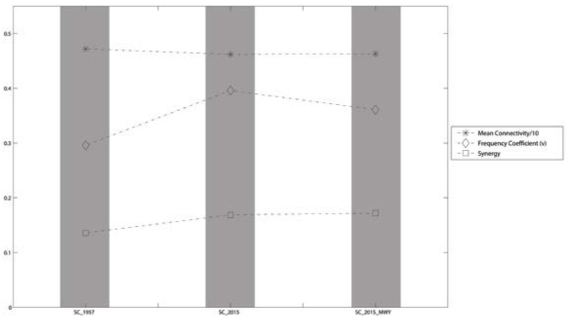

Fig. 4 A comparison among resilience indexes calculated for the Vesuvian area at 1957 and 2015, also considering the motorway A3 (SC_2015_MWY) (Cutini & Di Pinto, 2015)

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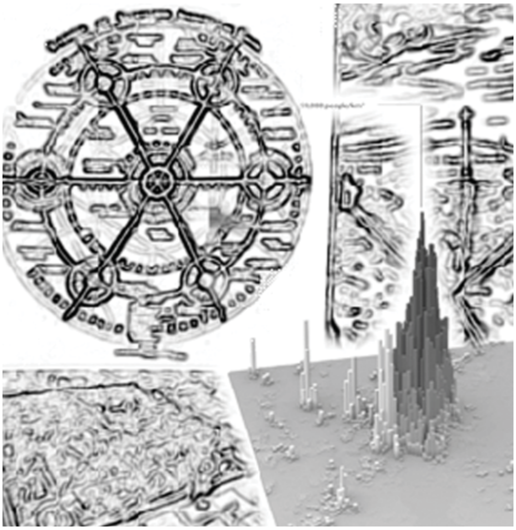

FROM THE RULES TO THE MODELS AND VICE-VERSA FOR A NEW PLANNING RATIONALITY

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ABSTRACT

This paper proposes an approach to the plan rationality based on the hypothesis of behavioral rules' permanence and on the possibility of their extrapolation in time and space.
This principle, which we recognize as traditional in the development of models in any research fields, is examined on the basis of applicative experiences and is discussed according to the point of view of the natural development of both research and training activities in those disciplines that aim to the understanding the territorial transformation processes and their government.
We affirm that a renewed rationality in planning should orient decisions towards territorial performances rather to define conformative schemes limiting adaptivity capacity of the territorial systems.

KEYWORDS
Rationality in Planning; Rules and Models; New Urban Agenda

1 INTRODUCTION

The commitment to achieve the satisfaction of what many scholars call "Right to Plan", as affirmed in the recent UN-Habitat international references, through planning instruments and procedures aimed at guaranteeing an a-priori rationality based on the three principles that represent the foundations of the 'social pact':

- equity;
- effectiveness;
- conservation of irreproducible resources (transgenerational value) that, for a long time, we place at the base of the request for disciplinary renewals.

In this perspective, this work proposes an actual reflection on the research of the logical bases that link: the permanence of society behavioral rules, detected by valid statistical methods, and the construction of models. The limits that we identify on the methodological level are linked to the persistence of a dense network of conflicts between groups and individuals who, following Simon, limits the robustness of rationality (Simon, 1972) to which we aspire. Such persisting conflict network should not lead to the uncertainty of an approach that becomes, day to day, more and more liquid. For these purposes, in the section two, after a lexical and semantic reflection on the expressions "rule" and "model", we discuss the link that arises between the research for rules and the construction of models as one of the preconditions of a systemic and adaptive approach. This link between rule and model has been associated to the attempt to classify rules and models, because their different nature shows how different the relationship is between them. The development of this research leads us to rediscover the principles of regional geography in order to recognize the persistence of behavioral rules especially linked to the role of physical and economic accessibility to goods, services and work, in different localization choices.

2 FROM RULE TO MODEL

The purpose of this section is to link opposites that seem irreconcilable as: Utopias, Ideality and the search for an a-priori rationality in the choices of resource allocation or activity location or territorial transformations management. Our attention to a renewed approach to the plan rationality has taken as a methodological reference the a-priori Kantian rationality as taken by Karl Popper in the well known "Congetture e confutazioni" (Popper, 1969) and, subsequently, projected in the field of public decisions by Faludi (1986, 1987) (Las Casas & Scorza, 2018). Although we focus on different topic, we must pay tribute to the contribution of Françoise Choay who, starting from the link between rule and model, has developed in his fundamental lesson on the architecture and architecture of cities (Choay, 1980). It will not be useless to start a brief reflection on dictionaries and thesauri referring to the two terms that, without any ambition of exhaustiveness, show how the proximity or the link between the two terms has always been very close. We limit ourselves to four references:

- "We have developed a computer model of the economy to predict what will happen in the future. (Cambridge Dictionary https://dictionary.cambridge.org/);
- Companies are developing new business models "(Cambridge Dictionary https://dictionary.cambridge.org/dictionary/);
- "A mathematical model is a description of a system using mathematical concepts and language. The process of developing a mathematical model is termed mathematical modeling. Mathematical models

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are used in the natural sciences (such as physics, biology, earth science, chemistry) and engineering disciplines (such as computer science, electrical engineering), as well as in the social sciences (such as economics, psychology, sociology, political science). (Wiki - https://en.wikipedia.org/wiki/Model 21-06-2018) A model may help to explain the effects of different components, and to make predictions about behavior. "(Wiki - https://en.wikipedia.org/wiki/Model 21-06-2018);

- Looking at synonymous and antonyms we can see meanings multiplicity of the term model (http://www.thesaurus.com/browse/model 21-06-2018).

Synonyms for model adj typical, ideal				**Antonyms for model**	
exemplary	facsimile	commendable	quintessential	abnormal	imperfect
miniature	imitation	flawless	typical	different	unusual
classic	perfect	illustrative	very	irregular	
classical	representative	paradigmatic		uncharacteristic	

Tab. 1 Synonymous and antonyms meaning table

The brief reconnaissance of the dictionaries already refers about the multiplicity of senses that the term "model" has and the correspondence whit an equally varied richness of meaning to the term "rule".

A brief overview of images, showed in the following figure, better than many words, evokes how different approaches, historical moments and authors have compared rule and model.

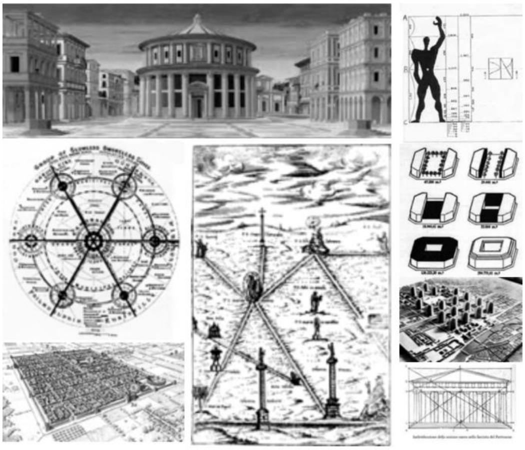

Fig. 1 The model image in the art of building cities

In all cases it can be said that the rule and the model have a strong didactic value, in the sense that they provide a way to interpret the past and the instructions for building the future. It is not important here to agree with one or the other school of teaching, but to agree on the learning process that in every cases it is possible to develop from each of them. Also giving meaning to the different learning phases developed as process of collective decision making to which the planning process is compared (Las Casas, 1984).

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2.1 WHICH 'MODEL' AND WHICH 'RULE'

In this section we propose, in a tentative way, the definition of (partially) corresponding types of rules and models.

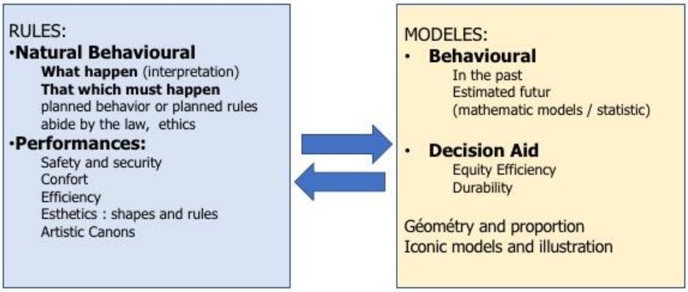

Fig. 2 Rule and model correspondence.

Firstly we restrict the field of discussion to the rules of localization and use of the space, distinguishing between those that regulated behavior in the past and those that can be taken in order to regulate future behavior (the plan). Among these we will distinguish those rules belonging to the positive right that to which behaviors has to be conformed, from those that are proposed to improve the performances of a territorial system. The former are based on the description-interpretation of the system, based on statistical models, but also on the ability to select and choose what "culture and sensitivity aspirations" become community ambitions. Following Armitage and Conner (2201) we will affirm that on a physiological and individual level conscious and planned behavior develops starting from beliefs and attitudes that determine subjective norms and intentions, therefore, behavior is finally conditioned by the way in which the external world perceives it.

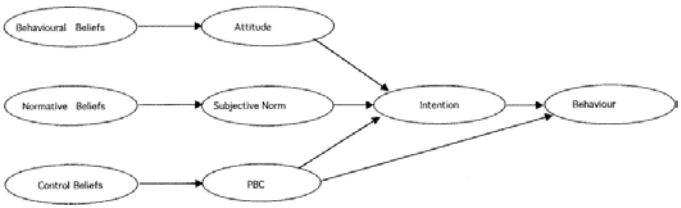

Fig. 3 "The theory of planned behaviour" (Christopher Jet al., 2001)

While, the latter invest culture, sensitivity and aspirations, but also the resources of a community. Therefore, their requirements will be: accountability, transparency and sharing (including sharing of uncertainty) and will have to provide effective performances in terms of comfort, safety, correct functioning, aesthetic aspects. The rules that control behavior in the past have been studied in the fundamentals works on Geography or Regional Economy and they gave origin to those formalizations that identify as "models".
Starting from von Thünen (1826), Zipf (1949), Christaller (1933), Alonso (1964) and recently, in Italy, Roberto Camagni (1993) produced an effective treatise on Regional Economy.

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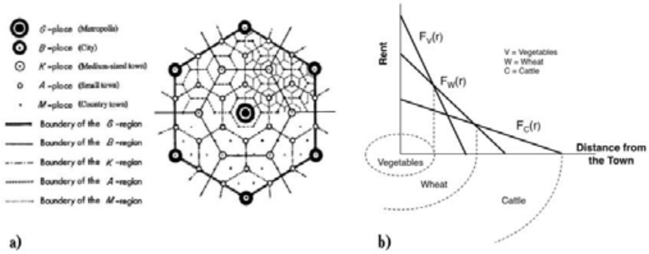

Fig. 4 Optimal urban structure Christaller Model (a) - von Thünen Model for Economic Rent"(b)

Starting from the observation about rule's stability, important models has been constructed: we quote Alan Wilson (1981) and Harris and Wilson (1978) most knew model which developed the idea that Human Behavior is conformed with minimizing of generalized transport cost.

$$T_{ij} = A_i B_j O_i D_j e^{-\beta c_{ij}}$$

$$A_i = \left[\sum_j B_j D_j e^{-\beta c_{ij}}\right]^{-1}$$

$$B_j = \left[\sum_i A_i O_i e^{-\beta c_{ij}}\right]^{-1}$$

Fig. 5 Harris and Wilson model (1978)

The robustness of the modeling is based on the fitting of the reproduced system with the real system. An intense research work has been developed in this sense, we cite the numerous contributions of Lombardo and Rabino in which correlation indexes higher than 90% were obtained. We cite among the many: Lombardo and Rabino (1984) and Lombardo (1991). In the case of decision-aid models we recall how the culture of optimization has developed towards a "decision aid science = Decision Aid Science" (Bouyssou, 1992; Roy, 1985). We will talk about 'Decision Aid' in relation to the awareness of the bounded rationality of a decision that has to deal with: the incompleteness and disparities of information, with the number of objectives and aspirations to which corresponds a multiplicity of criteria, with the theorem (demonstrated) of impossibility[1]. Therefore, according to Roy the decision-making process is developed proportionally to the growth of the information of the participants (learning process), who increase the attitude to take a shared decision. The most important component of this learning process (the *'apprentissage'* by B. Roy) concerns with the relative importance that each actor assigns to the different criteria and his availability to negotiate. The different decision-aid methodologies and related support tools develop representation (also graphic) of the consequences of a re-placement of aspirations, needs and preferences of the actors' system, including "*les agis"* (those who suffer the effects of the decision itself). It is the moment in which space is given to the participants' feelings and to the personal, perceptive and psychological aspects of the participants.

[1] The theorem of impossibility is due to Kennet Arrow in 1951 (see: Arrow, 1963) and his demonstration has fascinated scholars during the second half of the last century (see among others P. Martelli (1983), Forte and Mossetto (1977). The study of the conditions of the theorem and the pathways for relaxation of the constraints in a processual form has largely involved the students of the school of Roy and Bouyssou (1992) (See also: de Condorcet, 1785; Borda, 1781)

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3 INTERNATIONAL REFERENCES AND INNOVATION CONCERNS

Technological development and application of models for the design of planning choices are compared today with a heterogeneous references' framework that translate global policies into guidelines for the decision makers and planners according to a multi-scale hierarchy never completely defined in terms of competences (planning responsibility) and relationships between actors involved in the process. In this section we want to recall three domains of concerns that together contribute to define a framework of innovation instances for the discipline that allow us to reaffirm the *"right to plan"* towards the respect of the three principles of spatial planning (see point 1): equity ; efficiency; conservation of irreproducible resources. Moreover following domains of concerns gave us the opportunity to discuss, once again, the dualism between performance VS conformational planning. So let's look at:

- Climate Change (CC);
- Resilience and Disaster Risk Reduction and Management (DRR, DRM);
- New Urban Agenda (NUA).

These concerns are developed in the framework of the international debate and within the United Nations structures and determine an intense policymaking that generally flows into a number of sectoral (but mainly not integrated) planning tools that arise in a context of poor integration with the territorial choices of conventional urban planning.

3.1 CLIMATE CHANGE (CC)

The debate on the relationship between climate change and human settlement is formulated in the United Nations Framework Convention on Climate Change. The entered into force on 21 March 1994 (UN, 1994). The Kyoto Protocol is the international agreement linked to the UNFCCC recognizing the development of the "common but differentiated responsibilities" of the GHG emissions in the atmosphere as a result of more than 150 years of industrial activity. The Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012. It is relevant to note that a conformative structure has been proposed, based on a complex mechanism of International Emissions Trading with "assigned amount units" (AAUs) and how this has led to an overall failure. The Paris Agreement (UNFCCC, 2015) represents the actualization of global Climate Change policy framework. Starting from the assumption that the globalization of climate change is due to the global temperature, the agreement aims to strengthen the ability to deal with the impacts of climate change according with "Nationally contributions" based on an enhanced transparency of actions promoted by signatory nation. Such "Nationally contributions" (basically self-defined) goes beyond the conformative AAUs model which determined Kyoto's failure. We may define Paris Agreement as performance based global policy.

3.2 RESILIENCE

The second concern is represented by "resilience". Resilience comes in addition to risk and emergency management sector, and it is oriented to innovate the way in which planning instruments have to take into consideration the risk dimension in their background knowledge and, consequently, in the actions framework to be defined in order to overcome stresses deriving from the natural and/or human disasters (in a wider sense, Las Casas & Scorza, 2017). There is an impetus of the international community to produce "resilience

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complying" governance tools (at least to adapt existing ones) by coagulating technical and political working groups starting from the Disaster Risks Reduction (DRR) and Disaster Risks Management (DRM). In particular, we refer to the "Sendai Framework for Disaster Risk Reduction 2015 - 2030" (SFDRR) (UN, 2015). The attention to the concepts of Prevention, Preparedness and Mitigation once again put us in front of new challenges in planning disciplines. What is clear is that, in a definitive way, the DRM approach is oriented towards the definition of preparatory actions, based on an inclusive and participatory multi-actor structure in which the involvement of local communities represents an active process:

- strengthening skills (empowerment);
- active involvement (engagement);
- investments (from the scale of soft actions to large infrastructural investments) to reduce territorial vulnerability in a wider sense.

Such approach defines dimension of actions on the territory-community system aimed at improving performance in a dynamic vision taking decisions in relation to the knowledge of the dangerousness - exposure - needs of the specific community.

3.3 THE NEW URBAN AGENDA OF THE UNITED NATIONS

The New Urban Agenda of the United Nations (UN-Habitat, 2016, 2015, 2017) places among the cardinal elements of the shared vision of city and territory, not only the attention to the reduction and management of anthropic and natural risks, but also the protection of ecosystem resources and the promotion of "civic engagement" as participation and inclusion. It results in a system of territorial governance that re-launches the role of planning within an integrated system of tools and resources. Explicitly, it refers to the plan as a rational tool in which approaches for urban and territorial development has to be: sustainable, people-centered and inclusive and oriented towards the needs of gender, the elderly, the weaker. Such view appear to be opposed to the systematic weaknesses of discipline. It is structured on 15 categories ("pillars") that set priorities for developing operational solutions and, at the same time, a methodological framework for the renewal of urban and spatial planning tools to which we aspire:

Principles and Values (PV); Urbanization and Sustainable Development (USD); National Urban Policies (NUP); Rules and Regulations (RR); Urban Planning and Design (UPD); Financing Urbanization (FI); Urban Basic Services (UBS); Housing and Slum upgrading (HSU); Risk Reduction (RR); Research and Capacity Development (RCD); Human Rights (HR); Climate Change (CC); Gender (GE); Youth (Y);Local Implementation (LI). We read in those 15 pillars of the NUA the index of priorities to which a renewed approach to the plan should provide contributions. At the same time they define a complex system of questions on which robust models and the enriched availability of territorial information could determine advances in planning knowledge development supporting conflicting decisions on conservation/transformation and, widely, disciplinary innovation.

4 CONCLUSIONS

We are inclined to affirm that a renewed rationality in planning should orient decisions towards territorial performances[2] rather to define conformative schemes limiting adaptivity capacity of the territorial systems to

[2] Starting from the methodologic framework promoted by GPRA (USG, 1983).

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the new impulses that derive from the implementation of measures on the basis of mentioned concerns' domains. This general statement refers to a robust application of the planning process (Las Casas & Scorza, 2016) that we find in the approach of the modelers3 and that is opposed to the research for a-priori flexibility in the plan that establish a context of day by day decisions4 without ever proposing a vision of the future on which citizens, operators, investors can make their own accounts. To give a rigorous response to this need for knowledge and predictive capacities based on the simulation the territorial systems dynamics on the basis of a set of a-priori conditions gathered in the best modeling formulations, models development represents an effective perspective on which invest research efforts. The strength of our contemporary position is based on the assumption that the rigor of the procedures and formalizations resulting from a correct construction of territorial models have already demonstrated effectiveness and utility (in spite of those who have challenged it, sometimes in a gross way. We quote for all the well-known essay by Douglas Lee (1973) "Requiem for large-scale models"[5]). To better understand the references we are looking at, we refer to two important surveys (Oryani & Harris, 1997; Wegener, 1994a) in which the contribution of Giovanni Rabino is included. Rabino's researches produced important advances in both the theoretical and the applicative aspects (Lombardo 1991; Lombardo & Rabino, 1984) since the early 1980s. The aforementioned contributions by Wegener and Harris maintain, after twenty-three years, a great relevance because they show us a great ability to document (Wegener, 1994) and to argue (Harris, 1994) that we certainly did not find among the detractors of the modeling approach. However, it is not necessary to dwell on these arguments, neither on one side nor the other, but to take note of how an approach oriented to face the complexity of the territorial systems, through the construction of future scenarios, the composition of conflicts can provide methodological foundation to the instances of disciplinary renewal. Perhaps, on this critical basis, the 'pernicious' liquefaction of the foundations of the social pact (represented by the plan) that united the communities could be overcome by aligning the methodological research, the operational applications and technical practice on the 15 thematic pillars of the New Urban Agenda by UN.

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[3] "... I also think that someone else may object to the thesis that, referring to the aforementioned context of "knowledge society", ever wider spaces are being created for modeling practices ..." G. Rabino (2011).
[4] See wide research on liquid society by Z. Bauman (2013) and authors' considerations in (Las Casas & Scorza, 2017).
[5] Cfr.. Volume 60 Issue 1 1994 of the JAPA. See also the very important content, unfortunately not published, of the workshop organized by Giovanni Rabino in 1996 at the Milano Polytechnic on the occasion of the publication of the mentioned Volume of the JAPA (in particular see Klosterman, 1994a, 1994b; Batty, 1994; Wegener, 1994b; Harris, 1994; Lee, 1994 who reconsider the work of Lee (1973) after twenty years, with the participation of Michael Wegener and Gabriele Scimemi.

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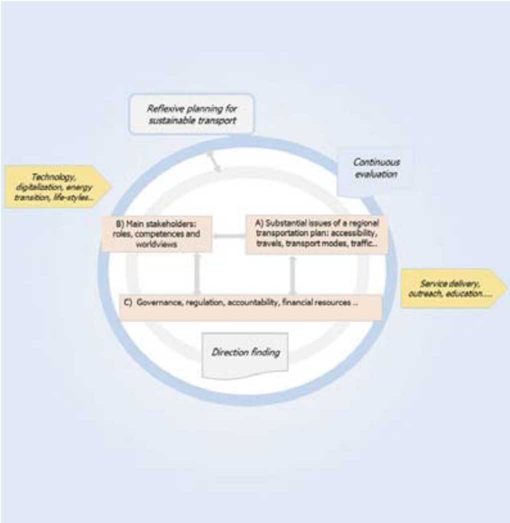

A META-MODEL OF REGIONAL TRANSPORTATION PLANNING

THE CASE OF PIEDMONT

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ABSTRACT

Recently, a Mobility and Transportation Plan (MTP) has been passed in the Piedmont region which paves the way to a new course in regional transport planning. A few aspects distinguish it from earlier approaches: a) a future-oriented vision centered on sustainability principles; b) the attention paid to institutional capability and governance; c) the focus on plan performance and evaluation. The notions are increasingly popular in the transport literature. Their practical application however, brings up a number of questions concerning the design-implementation path. This paper suggests that embracing a modeling oriented perspective can help address them. Discussion is organized in four sections. The first introduces the main themes and gives an overview of the Piedmont MTP. Then a closer look is taken at the modifications in the theoretical, process and reflexive dimensions of transport planning. It is argued that sustainability calls for deeper insights into how the theoretical and process dimensions relate to each other in implementing the plan. To address the linking the third section suggests a meta-model whose main components are continuous evaluation and direction-finding. A conceptual framework is then proposed which may be used to guide the developmental path of the Piedmont MTP. To prompt its application social network analysis is used to investigate the plans' general structure. Finally, the last section summarizes the main findings and provides suggestions for future research.

KEYWORDS

Regional Transport Planning; Sustainable Transport; Reflexive Planning; Transition Management; Evaluation; Policy Packaging

1 INTRODUCTION

Over the last two decades, the issue of transport sustainability has gained importance in the policy agenda of most developed countries (Banister, 2008; ERTRAC-ERRAC-ALICE Working Group on Urban Mobility, 2017; European Environment Agency, 2008; Masser et al., 1992; United Nations Secretary General's High-Level Advisory Group on Sustainable Transport, 2016). In the Piedmont region too, several initiatives have been carried out by the institutional departments with responsibility for dealing with road safety, gasoline consumption and greenhouse gas emissions[1]. Although some of the projects have entailed substantial financial and governmental efforts, little evidence exists about the extent to which these initiatives have contributed to the sustainability of the regional transport system.

The situation is changing as a result of a revival in the debate about the environment-development relationship and the spur of a number of concomitant factors.

First, on the policy ground, a major impulse has been given by the European Structural and Investment Fund program. In order to ensure consistency of national and regional transport investment priorities with the TEN-T Guidelines, it required the authorities receiving funds to draw up a long-term framework for transport strategies and funding priorities[2].

Second, technological progress (Corwin et al., 2015) and the spread of Information Communication Technologies (ICT) are a major driver for change, and have a strong impact on travel behaviours, traffic levels and transport externalities (Black & van Geenhuizen, 2006; Hanson, 1998; Gössling, 2017; van Wee et al., 2013). In Piedmont, results from the latest individual mobility surveys suggest that ICT diffusion has probably played a part in reconfiguring mobility patterns and decreasing the number of residents' daily trips (Occelli & Sciullo, 2015).

Digitization has also been a major stimulus for a moderate but steady modernization of the government sector since the 2000s[3]. As documented in the e-government and public management studies (Gil-Garcia, 2012; Osborne & Brown, 2013), it has opened potentially large windows of opportunity for innovation to occur in conventional policy practices.

In Piedmont, as in many other Italian regions, digitization prompted a revision of many back-office procedures but also exposed weaknesses in the e-readiness of the incumbent government agencies. In some cases, it even challenged the capability of public organizations to provide guidance and brought to the fore the opportunity to develop new governance approaches (Inguaggiato & Occelli, 2014; OECD, 2011; Occelli, 2012).

Finally, the impact of the recent economic crisis has dramatically curtailed the public funding of many local authorities, severely constraining the delivery of transport services. Even more notably, it has provoked a

[1] The range of initiatives can be appreciated visiting the regional institutional websites: http://www.regione.piemonte.it/trasporti/sicurezza_stradale/index.htm http://www.regione.piemonte.it/ambiente/rumore/index.htm http://www.regione.piemonte.it/ambiente/aria/mobilita.htm

[2] http://www.agenziacoesione.gov.it/opencms/export/sites/dps/it/documentazione/AccordoPartenariato/Accordo_di_Partenariato_ALL_IV_RACCORDO__Prioritx_investimento_Risultati_attesi.pdf. (Objective 7, sub b)

[3] According to Coleman (2008), "E-governance entails the digitised coding, processing, storage and distribution of data relating to three key aspects of governing societies: the representation and regulation of social actors; the delivery of public services; and the generation and circulation of official information" (p.8). Digital governance is characterized by four main features: a) a transition towards networked organizations, in which information is exchanged among dispersed nodes; b) the availability of a large quantity of information, whereby the organization success is highly dependent on the network's capability to generate, exchange and share information; c) the establishment of two-way communication with the public; and d) the transformative process of organizational behavior.

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sense of uncertainty (Lyons & Davidson, 2016), causing the regional incumbents to wonder about the viability of their programs. These circumstances gave rise to the general context in which the regional Mobility and Transport Plan (MTP) has been recently passed. The plan takes up the European challenges of sustainable transport and climate change, and commits to a few topics that mark a distance from previous approaches. In particular: a) it lays out a future-oriented vision; b) it pays attention at institutional capability and governance; and c) it focuses on plan performance and evaluation.

Although these notions are well established in the literature, their application heralds a novel stage in regional planning practice. It does, however, bring up complex questions concerning the design-implementation path that are by no means unique to the Piedmont region.

The paper aims to formulate them more clearly and then continues the discussion in four sections. The first opens the debate: an overview of the core focus of the Piedmont regional transport plan is used to introduce the discussion. The second provides the basis for the arguments and takes a closer look at the main features of transport planning dimensions, e.g. theoretical, process and reflexive. By highlighting some recent modifications of these dimensions the discussion sheds light on a few requirements of long-term planning, and namely: a) the fact that it has to handle evolving phenomena and at the same time create the institutional and governance conditions for dealing with the transition; and b) the fact that it has to evaluate whether the plan is achieving the sustainability targets and, at the same time, provide the necessary resources for the evaluation activity.

In the third section, we argue that to meet those requirements, long-term plan strategies may benefit by adopting an approach entailing interrelated perspectives of continuous evaluation and direction-finding. To give ground to these notions a meta-model is outlined and results of an application to the Piedmont MTP are presented as an example. Finally, the last section summarizes the main findings and provides suggestions for future research.

2 AN OVERVIEW OF THE NEW REGIONAL MOBILITY AND TRANSPORT PLAN

The concept of sustainable transportation involves the balance between the economic and social benefits of transport and environmental protection (Litman, 2003). Drawing upon the concepts pioneered in the Brundbant Report (World Commission on Environment and Development, 1987), a sustainable transportation system is one that (European Union Council of Ministers for Transport and Communications, 2001):

- allows individuals and societies to meet their access needs in a manner consistent with human and ecosystem health and with equity within and between generations;
- is affordable, operates efficiently, offers choice of transport mode and supports a vibrant economy;
- limits emissions and waste within the planet’s ability to absorb them, minimizes consumption of non-renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.

These notions are at the heart of the new Piedmont Mobility and Transport Plan (MTP), which is a long-term comprehensive strategic framework spanning from design-oriented aspects to practical issues of policy implementation. Basically, the framework is organized around three core topics: general principles, implementation guidelines and recommendations (Regione Piemonte, 2016).

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The general principles acknowledge the fact that the plan views transportation holistically.[4] This means that the plan is oriented at addressing the evolving links between transportation and the regional activity system; it is also concerned with the capability of the transportation system to sustain its own operations. The principles focus on:

- a long term vision of piedmont's future which shapes the strategies for sustainable transportation and identifies the main goals and measurable targets to be achieved by 2050. The vision is meant to guide planners' moves from strategies to actions and help elected officials and stakeholders better understand plan rationale;
- a developmental logic which favors forward-looking planning activities and promotes social, environmental and economic sustainability goals. Although this principle may sound trivial, complying with it implies a shift from earlier planning interventions often dominated by urgency measures;
- a rational design approach to transport service delivery, tailored to the regional mobility demand. it advocates the integration of different transport modes, also by pooling the available financial resources. attention is paid to recognizing different mobility profiles at sub-regional level, depending on the different characteristics of travel patterns and transport connectivity networks.

The implementation guidelines maintain that:

- MTP's governance should span across the various regional jurisdictions and spatial planning levels, involving all the relevant actors;
- to roll out the mtp, short-term transport programs for passengers and freight have to be drawn up. they will set their own objectives and see to the consistency of their pathways in order to achieve the main targets of the mtp;
- monitoring, evaluation and reporting should be carried out in order to assess plans' achievements and adjust their pathways.

Finally, the recommendations recognize the fact that any choice in a given policy domain necessarily influences and is affected by those made in other domains. The following topics may help integrate policies across regional departments:

- the logical and substantial coherence among sector plans such as those dealing with socioeconomic growth, territorial development, landscape protection and air quality;
- financial constraints and funding options;
- a common approach to monitoring and evaluation of plans across the different sector policies.

The scheme in Fig. 1 provides an overview of the plan's targets and main areas of intervention (action domains).

[4] According to the Italian Constitution, public sector competences are distinguished according to a three-tiered level: national, regional and mixed. Transport belongs to the last type. Transport and mobility planning procedures result from a complex multilevel governance system. In a nutshell, the main responsibility of the Transport Ministry is for interregional and international infrastructure and services. Regional and Local Authorities see to the management of local roads, road traffic and to the provision of public transport services. The Transport Authority is an independent national body which provides regulations for service quality levels. The main assignment of a regional transport plan is to assure a coherent framework for development programs regarding road infrastructure and public service provision for passenger and goods. It generally has a 10-15 year horizon but this is discretionary, depending on the planning goals of regional transport authorities.

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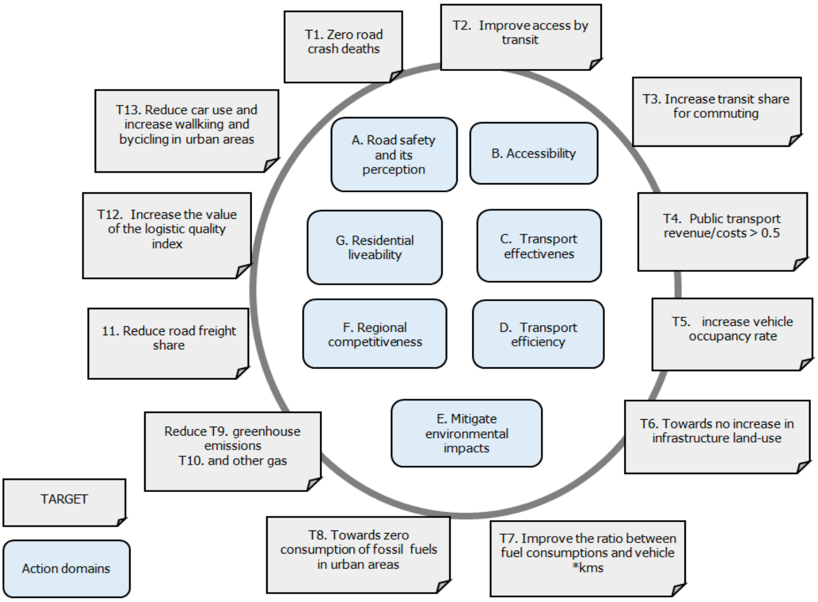

Fig. 1 An overview of the Piedmont Mobility and Transport Plan: action domains and targets (*)

(*) Each target is associated with a quantitative indicator not shown in the figure.

The list of actions by intervention areas is summarized in Fig.2.

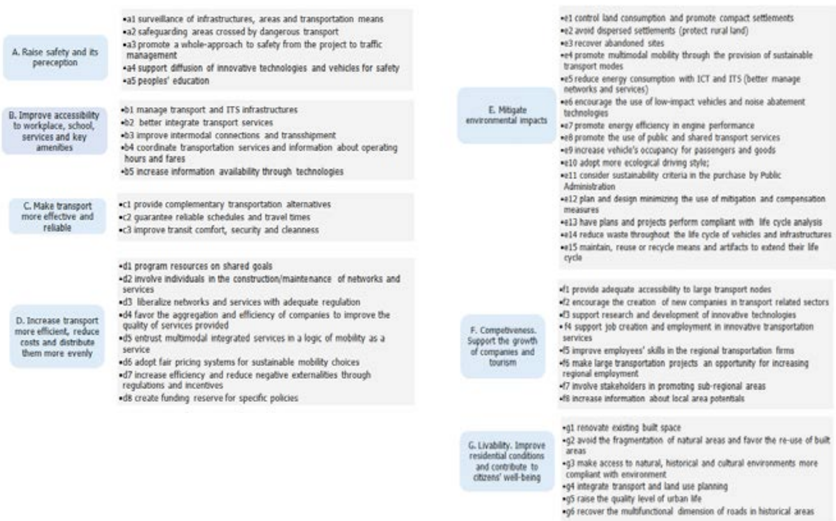

Fig. 2 List of actions by domains in the Piedmont Mobility and Transport Plan

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3 TRANSPORT PLANNING AND A FEW KEY TRANSFORMATIONS

3.1 THE PLANNING DIMENSIONS

A transport policy is conventionally understood as a set of norms, regulations and action programs whose aim is to respond to present and future mobility of people and goods (Rodrigue et al., 2006). Since they own and manage many components of the transport system and deliver important public services, governments have a major responsibility for transport policy, although other actors such as, experts, citizens, firms and ONGs have a relevant part in it. Depending on their institutional mandate and spatial jurisdiction, they periodically engage in developing plans.

A formulation reflecting the endeavor of present day planning is the one by the U.S. Department of Transportation, which says that: "Transportation planning plays a fundamental role in the state, region or community's vision for its future. It includes a comprehensive consideration of possible strategies; an evaluation process that encompasses diverse viewpoints; the collaborative participation of relevant transportation-related agencies and organizations; and open, timely, and meaningful public involvement" (U.S. Department of Transportation, 2007).

When examining the rationale of this formulation, we can see that it has a threefold dimension: theoretical, e.g. what the plan wants to achieve and why, the process to be adopted, e.g. how the plan is going to unfold, and reflexive, e.g. how these two dimensions relate to each other in supporting the plan's development. Let's briefly address these dimensions and highlight some aspects of their recent evolution.

The theoretical dimension involves the set of constructs and propositions that are established to achieve particular objectives relating to socio-economic development, the functioning and performance of the transport system (Rodrigue et al., 2006). This dimension essentially captures what for a community, given its development stage, e.g. level of technology and socioeconomic progress, are the main transport questions to be addressed. In most Western developed countries, the sustainability-climate change interactions, mentioned earlier provide new lens to look at them.

The planning process dimension relates to how a transportation plan is put into practice. It has three basic components (Pas, 1995), which are often interlinked in various ways, depending on the type and level of involvement of the different actors. There is a preliminary phase in which the transport organization examines the transport needs of the study area and identifies the goals and objectives to help address those needs. Data on the socioeconomic, spatial and mobility characteristics of the area are collected to and some preliminary planning alternatives may be formulated.

Secondly is the technical analysis phase which is concerned with the investigation of changes in travel demands and their likely impacts on the transport network, mobility services and on the broader socioeconomic and environmental systems. In this phase, analytical tools and mathematical models are often used to analyze travel demand and its sensitivity to the plan interventions.

These tools belong to well-established analytic traditions; there is the so-called, sketch planning approach (Givoni et al., 2012) which provides aggregate insights of transportation and land use demand for certain impacts; the four step modeling for many years has been the main analytic framework for estimating mobility flows in urban areas (McNally, 2007; Sheppard, 1995); activity-based approaches which take into

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account the scheduling of activities in time represent the current state-of-the-art in travel demand models (Arentze & Timmermans, 2000)[5] The third phase in the transportation planning involves program implementation, monitoring and assessment of the results. It is the phase which has probably attracted the greatest attention in the last decade, notably as a result of the increasing amount of data available on mobility (number of trips, distances travelled, road injuries, modal share, etc.) and its environmental impacts (greenhouse emissions, energy consumption, etc.) (Litman, 2016). Due to the progress in ICT, increased data availability has played an essential role in defining measurable planning targets and developing appropriate analytic tools (indicators) to measure the results of transport plans (Gillis et al., 2016; Gudmundsson, 2001; Litman, 2016). Within more environmentally sensitive contexts, it similarly enabled the setting up of performance-planning frameworks which allowed actors to make sense of the progress being achieved (Grant et al., 2014; Marsden & Snell, 2009), manage projects' roll out (Civitas, 2012) and assess the sustainability outcomes. The last dimension underpinning the planning activity relates to the reflexive aspect.

In common language, the term reflexive refers to the presence of a circular relationship between an entity and itself. It applies to human thought, providing grounds for debate about learning and knowledge, as well as to organizations' own production, raising questions about evaluation of the efficiency and effectiveness of their actions. According to this general view, therefore, reflexivity spans across the material, functional, and cultural dimensions of any activity system. In this sense, it is but a constitutive property of these systems: for human organizations, in fact, it is simply impossible not being reflexive (Lynch, 2000).

In the planning activity, more specifically, the reflexive dimension is an intellectual endeavor that aspires at enhancing the understandings of how planning operates (Howe & Langdon, 2002). In this sense, it sets the conditions for the mutual development of the theoretical and process dimensions. It incorporates requirements of directionality and normative orientation, leverages organization's capabilities to engage in actions, and lays down the appraisal conditions for the plan's appropriateness.

Ultimately, it shapes the essential linking between values, actions, and outcomes. Insights into this linking are crucial for the plan's own viability. On a practical ground, the reflexive dimension incites a community to reflect about the current maturity level of its sustainability situation.

It also raises the question about the extent to which this level is likely to be affected by the unfolding of a long time span plan. Dealing with such questions is fraught with uncertainties. As the recent literature on adaptive policies has pointed out (Haasnoot et al, 2013; Walker, 2015), they call for a renewed attention at the relationships between the different levels of plan's project development, e.g. operational, tactical and strategic.[6]

[5] Many applications of the activity-based approach exist nowadays. See for example the case of the Baltimore Metropolitan Area (Cambridge Systematics, 2014), Copenhagen (Vuk, 2011), and the Atlanta Region (Atlanta Regional Commission, 2018). In the latter an integrated system of three sophisticated models was used: regional socioeconomic forecast is disaggregated by a small-area model, which then feeds distributed socioeconomic data into an activity-based travel model.

[6] The operational level accounts for the everyday management of traffic flows by different transportation modes; the tactical level handles people's daily trips and transport services over a medium time span; the strategic level deals with future transport demand resulting from population and activity changes in an area, as well as from broader long term societal transformations and technological progress.

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3.2 REMARKS ABOUT THE REFLEXIVE DIMENSION

According to Kauffman (2009) a reflexive domain is an arena where actions and behaviors carried out by actors that transform a domain can also be seen as the elements that make up the domain. Assessing certain behaviors is part of actors' learning and is likely to accrue to the domain's improvement. A reflexive domain therefore can viewed as a combination of an existing structure and an incitement to create new ones. It reflects actors' intrinsic tendency to search for novelty and, at the same time, is a source of innovation. In this effort actors have to make some sort of anticipation: they exploit their ability to make abstraction of regularities they have observed. According to von Gansfwerveld (1998) there are two main forms of anticipation.

The first relates to actors' familiarity with specific associations of actions they have experienced earlier and takes the form of implicit expectations (that are a prerequisite in many actions).

The second is an expectation of a specific future event that derives from deliberate abstraction from actions and the consequences observed in past situations. Both these forms of anticipation underlie the recent advances in transport studies concerned with sustainability. The former underpins the performance-based approach set forth in more innovative planning practices (Grant et al., 2014); the latter has been taken up in scenario-based studies for investigating future transport demand (Bernardino et al., 2015; Chatterton & Wilson, 2014; Timms et al., 2014). While overlapping with the preceding ones, there is an additional form of anticipation (von Gansfwerveld, 1998), which stirs today's sustainability debate. It is the anticipation of a desired event, situation, or goal, and the attempt to attain it by generating its cause. This is a delicate undertaking as it does not solely involve the choice of goals, but also presses the involved actors to focus on the consequences of their actions and their ethical implications (Nelson, 2004).

The last form of anticipation is at the core of the quandary exposed by the reflexive dimension. On the one hand, investigations into mobility futures expose the un-sustainability of many current transportation situations; the acknowledgment imposes restrictions and urges a paradigm shift towards more innovative forms of mobility (Litman, 2003; United Nations Economic Commission for Europe, 2014; United Nations Secretary General's High-Level Advisory Group on Sustainable Transport, 2016). On the other hand, reflexive thinking makes it necessary to re-order priorities and measure the potential accomplishments, appreciate the innovations and benefits from transforming the existing transportation systems and policies into more sustainable ones (de Bruijne et al., 2010; Gudmundsson, 2001; Himanen et al., 2006).

This kind of dilemma is not unique to transport. Several research streams have recognized the complexity and uncertainties of policy approaches which have to *muddle through* environmentally sensitive development, such as the studies on the management of system transitions (Jessop, 2003; Loorbach, 2010; Kemp & Loorbach, 2003; Smith et al., 2005), the development of adaptive approaches to planning (Haasnoot et al., 2013; Marchau et al., 2009; Walker, 2015) or, even more generally, the encouragement of social learning as an alternative form of governance (Ison & Collins, 2008). Notwithstanding their differences, all these studies share an effort to suggest action pathways and have in common the following general facets.

First, they recognize that great uncertainties exist in any enterprise which opposes the linear cause-effect approach usually adopted in conventional planning. Second, they note that the most severe policy problems often appear in the implementation stage. Third, they focus on the notion of agency, and notably on the fact that actors' ability to learn and take action is central to any transformative undertakings.

Finally, they point out that in order to support the desired changes any proposed approach should:

- account for how actors organize themselves within and outside public organizations;

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- enable actors to engage in continuing dialogue and resource-sharing;
- provide meaningful evidence about the evolving situations;
- make it possible to develop mutually beneficial joint projects;
- help manage the contradictions likely to emerge when implementing projects.

How the actors involved in planning activities handle the data – information – knowledge continuum and share it with others is also crucial aspect in the approach. Two aspects are worth mentioning here (Occelli, 2014).

First, the question of how individuals build up the conceptual framework, the so-called worldview, that ties together data, information, and knowledge and allows them to position themselves in the world and act reflexively upon and within it.[7]

Second, they require actors to share a mode of enquiry enabling them to exchange knowledge about the world and worldviews, and above all assess what is gained from sharing it. There is no single or definitive recipe for this. As highlighted by Nelson (2004), its requirements are very different from those maintained by truth or ideal-seeking inquiry systems: the former being concerned with a search for what is true, the latter with what would be the ideal. The new requirements call for an ability to link inquiry and action more effectively:

- yielding knowledge about what is desirable for the key stakeholders who are expected to benefit from the outcome of the adopted approach;
- discerning what would be a "desirable addition to the real world" (Nelson, 2004) (see the previous remarks about anticipation).

A distinctive feature of this mode of enquiry, therefore, is the existence of explicit relationships between those engaging in the enquiry, that is the scientists, citizens, policy-makers, and laymen who will be affected by the results of the enquiry process (that which is desirable) (Occelli, 2015, 2016).

4 A CONCEPTUAL MODEL TO BACK LONG-RANGE PLANNING

For long term planning to cope with an evolving context, a strategy is needed to deliver effective actions and be practicable. This echoes, to some extent, longstanding questions about the formation of strategies in organizations, and the variety of forms they can take when having to respond to specific circumstances (Mintzberg & Waters, 1985). When confronted with their realization, strategies do, in fact, tend to fall between two extremes: the pattern of actions is either exactly as intended (a perfectly deliberate strategy) or consistent though unintended (an emergent strategy).

While recognizing this possibility, the previous discussion suggests that for a strategy and/or planning activity to be viable, it should be based on deliberate learning derived from the inquiry-action pairings actors can mobilize as they participate in the activity.

[7] A worldview allows individuals to understand their surrounding environment, the larger societal world, their place in them; even more notably it permits them to make critical decisions for shaping their own future (Aerts et al., 2007). For the authors a worldview consists of different components, aimed at answering a specific set of questions about the world: a) a model of the world (who are we?); b) explanation (why is the world the way it is ? Where does it all come from ? Where do we come from ?); c) futurology (where are we going); d) values (what is good and what is evil ? What for ?); e) action (how should we act ?); f) knowledge (how do we acquire knowledge and construct reliable models ?); g) building blocks (how do we put together knowledge chunks which can be already found in existing theories, models, concepts, guidelines and values, scattered over the different disciplines and ideologies ?).

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To engage in such an activity the reflexive dimension is mobilized to address two broad but fundamental questions:

- How can we know if our transportation system is becoming more or less sustainable and whether the policy measures adopted are achieving their intended goals ?
- How can we provide directions to action courses and align them with evolving sustainability goals?.

To help answer these questions the notions of continuous evaluation and direction-finding are suggested and briefly reviewed. Building on the arguments a conceptual framework is then proposed which may serve as a reference for thinking about plans' strategy design.

4.1 CONTINUOUS EVALUATION

Continuous evaluation is based on the concept of developmental evaluation. According to its proponent (Patton, 1994), "developmental evaluation is a way of being useful in innovative settings where goals are emergent and changing rather than predetermined and fixed, time periods are fluid and forward-looking rather than artificially imposed by external deadlines, and purpose is learning, innovation, and change rather than external accountability (summative evaluation) or getting ready for external accountability (formative evaluation) "(p. 318).

The salient features of the approach are presented in Tab. 1 and its main underpinnings can be summarized as follows (Gamble, 2008):

- an openness towards new thinking in order to conceptualize and articulate policy problems as they unfold over time, helping to frame the issue and its dynamics;
- attention to the testing of interventions meant to solve the policy problems. this implies the timely collection of feedback and providing indications for refinements, using appropriate methods;
- tracking of the overall policy path, recording the directions taken and their consequences, as well as those not taken. This serves to make the decision-making along the chosen path more transparent and generate valuable data useful for dissemination, and accountability.

What this perspective ultimately provides is a sort of thinking scaffolding in which actors' different worldviews can be accommodated, aligned and tested in order to explore different programs. In this respect, it may help recognize action failures and facilitate learning (Guijt et al., 2012). By improving the linkages between the plan's informational, decisional and operational functions and between the plan's outcomes and their societal impact, it may stimulate actors to generate new ways of learning as well.

An important pre-requisite for the approach to be successful is that it should enhance the ability of actors to meet their wants by making the inquiry-action pairing more effective. As pointed out by Avelino (2009), however, actors' empowerment does not automatically follow from their participation. It depends on the worldviews and needs they have to interpret and assess their tasks in specific situations.

Their sense of meaning, competence and bearing in their everyday activities is decisive in creating the policy building blocks to achieve long term policy goals. An additional pre-requisite which enables knowledge-sharing and group decisions is associated with the possibilities provided by an ICT *wired* environment as they facilitate actors to jointly build forms of knowledge better suited to the tasks they have to accomplish (Norman, 1993; Occelli, 2015, 2016).

Engaging in developmental evaluation is also necessary for enabling such a context. As explained by Gamble (2008), the focus of the undertaking is "on the relationships between processes and outcomes,

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understanding the connections in deeper ways and developing effective approaches that produce innovative results appropriate to, and meaningful within, the emergent context” (p. 56).

KEY AREAS	CONTENTS
Purposes	supporting development of innovations and adaptation of interventions in dynamic situations
Mindset	exploring possibilities, generating ideas and trying them out
Target of change	system changes and processes
Evaluation focus	timely feedback to support actions
Evaluation locus	it is in-between theory driven and participatory approached
Modeling and methods	using system thinking to detect patterns
Measurement approach	Implementing tracking mechanisms to detect phenomena as process unfolds
Evaluation design responsibility	evaluation is co-created with those engaged in the change
Evaluation approaches	methods are chosen in service to developmental use; judgements about methodological quality are context dependent; abduction and pragmatism
Evaluation results	detecting effective principles that can inform practice and be adapted to local context
Evaluation impacts	nurturing learning interest and contributing to the building of long term capacity

Tab. 1 Main aspects of the developmental evaluation perspective (Patton, 2011)

4.2 DIRECTION FINDING

Reflections about how a system handles the processes it carries out in order to adapt to internal and external modification offer direction to long-term planning and strategy design (Friend & Jessop, 1969; Jessop, 2003; van Buuren, 2009).

This is a major focus in the transition management literature, whose insights are also valuable for understanding changes in transport socio-technical regime. A socio-technical regime can be broadly understood as a relatively stable configuration of institutions, techniques and norms as well as networks and practices that make the normal development and use of technologies possible (Smith et al., 2005). A regime, furthermore, is also expected to achieve the socially-valued functions it helps to constitute.

To govern the transition of a socio-technical regime and guide it towards a more desirable end-state, two main determinants must be balanced out: selection pressures and adaptive capabilities (Loorbach, 2010; Kemp et al., 2011). Selection pressures account for the various internal or external factors that may affect a system and modify its regime. Two aspects are important:

a) how the factors are articulated in a given context and coherently oriented in a particular direction, and b) how they are made explicit and translated into forms which facilitate the formulation of responses. Adaptive capability represents the ability of a system regime to respond to selection pressures, given the resources and capacity. It pertains to the functions that make it possible for the system to reproduce itself and cope with changes without falling apart.

In Smith et al. (2005), for example, two major analytic dimensions are distinguished for conceptualizing how to handle the transition process:

- the level of coordination between actors, as this determines whether responses to selection pressures are purposefully governed (high coordination) or emerge from self-organizing situations (low coordination);

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- the degree to which responses are based on internally or externally available resources. if they are internally available, it is likely that modifications of the existing regime will take place incrementally. If this is not the case, more structural changes may be required.

By combining these dimensions an ideal typology of strategies for steering system transitions and governs their processes[8] is obtained. It can be briefly summarized as follows:

- endogenous renewal (coordinated response, internal adaptation): this occurs in situations where actors make conscious efforts to respond to selection pressures. these, in addition, are clearly articulated and responses, in terms of both resources and knowledge, can be based on the existing system regime;
- intentional/planned transitions (coordinated response, external adaptation): these refer to changes that are deliberately intended and pursued from the beginning to account for an explicit set of societal expectations or interests. in this case, external social actors have a main role in expressing the factors of change, and creating the conditions for responses. the building of a consensus-guiding vision which identifies the selection pressures may also contribute to steering the changes;
- re-orientation of trajectories (uncoordinated response, internal adaptation): this reflects situations in which the system regime is exposed to unpredictable modifications which may be exogenous or endogenous. to absorb the shocks, the system regime has to be altered, although factors of change may not be clearly identified and responses are difficult to coordinate. in this case, focusing on the selection pressures may be the best strategy to managing the transitions;
- emergent transformation (uncoordinated response, external adaptation): it accounts for regime changes that have an apparently autonomous logic. an example of this type of transition can be found within scientific activities whose findings have a major disruptive potential, as in the case of progress in information and communication technologies. The fragmented situations experienced by many local governments as a result of the latest economic crisis exhibit these features.

These governance processes are understood as heuristic schemes that can be used either for an empirical analysis of specific contexts or for providing normative insights. As for the latter, the authors emphasize that raising awareness about the governance alternatives may help identifying those transition process with the more desirable outcomes.

4.3 A SCHEME FOR TRANSPORT LONG-TERM PLANNING

Developmental evaluation and direction-finding are complementary activities of the planning reflexive dimension. They involve, to a different extent, all the elements of a transport planning system.
The general scheme in Fig. 3 graphically illustrates this fact in the case of the Piedmont MTP. The scheme is not meant to be comprehensive but simply accounts for those elements which are currently most relevant given the plan's maturity level. Four types of elements are shown:

- the structural components which include: a. goals reflecting the scope and extent of the transport activity system, given the set of values, beliefs and preferences for the community; b. actors, that is the organizations and interest groups involved in the planning activity; c. functions, that is the kind of
- tasks actors carry out to support the working of transport activity system for achieving its goals;

[8] The proposed typology is discussed by the authors making reference to large-scale technological changes in the energy sector.

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- the types of activities. they account for the operations involved in the plan's implementation process such as actor's engagement, decision-making, monitoring and evaluation;
- policy outputs. They refer to the set of main kind of deliveries a plan is expected to provide during its pathway;
- external drivers. They reflect all those factors which affect a transport activity system, but have no direct roots in the planning area.

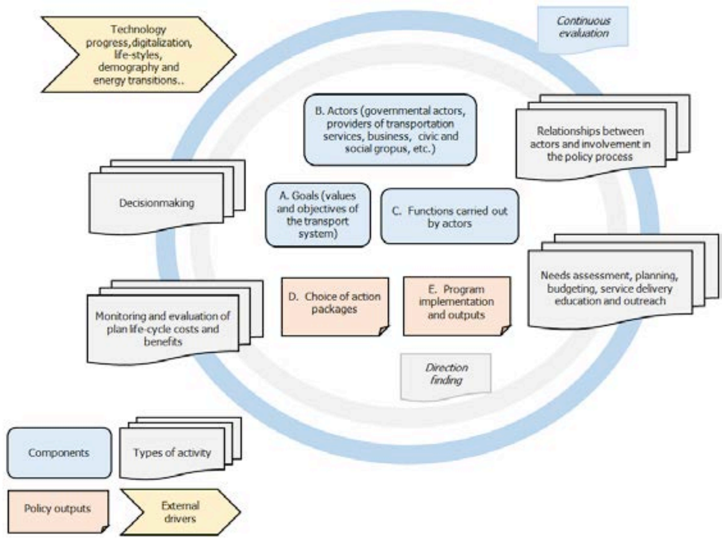

Fig. 3 A scheme for long-range transport planning

5 AN APPLICATION TO PIEDMONT PLANNING CASE

The preceding arguments offer a number of stimuli for thinking about the implementation of the Piedmont Mobility and Transport Plan. For example, they raise the following questions: a. how the plan's interventions might be packaged in order to achieve the desired goals most effectively?; b. how this packaging may be affected by actors' involvement?.

As a preliminary step to address these questions, an exploratory exercise has been undertaken which makes an educated guess about the configuration of plan's actions and partaking of different types of actors.

First, the elementary measures associated with each of the (seven) action domains (Fig.2) have been analyzed and their likely relationships identified. The graph in Fig. 4 visualizes the resulting network. It provides a synthetic account of the overall field of interventions. For example, it reveals that stakeholders' involvement in the promotion of sub-regional area (f7) is the plan's action most affected by the other interventions.

Then, building on the plan's general principles, a typology of actors' involvement has been identified. As suggested by the earlier arguments about strategy formation, it accounts for the different actors who may have a responsibility in carrying out a certain action. Four groups have been defined which ideally include a progressively larger number of actors: group 1 represents the regional transport department; group 2

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includes also other regional departments, dealing with urban, economic and environmental planning; group 3 adds to the previous actors, local public authorities having transport or urban management responsibility at sub regional level; lastly, group 4 consists of other regional stakeholders such as private transport agencies, universities and citizens.

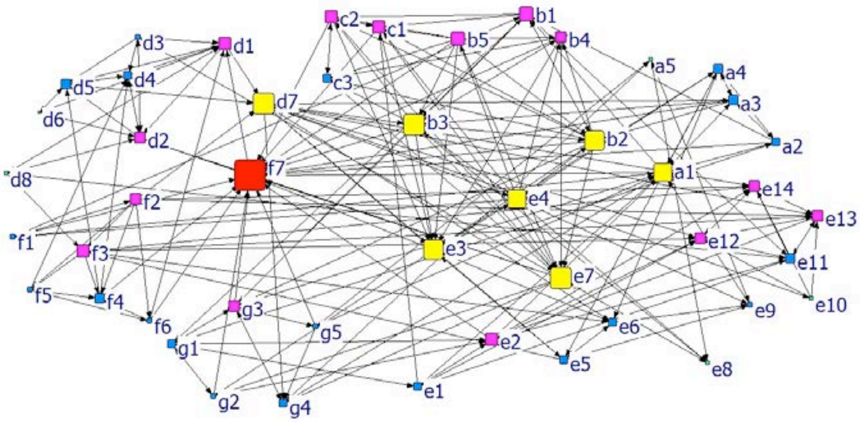

Fig. 4 Action relationships in the Piedmont Mobility and Transport Plan (*)

(*)The color distinguishes the level of node in-degree in the network representation.

Depending on its content, each intervention has been associated with one of the four actor groups and a data matrix obtained: rows represent those plan's actions which are assumed to be under the actors' own responsibility and columns the seven action domains.

The affiliation networks associated with these matrices highlight the extent to which interventions may be shared by each couple of action domains, Fig.5. Inspection of these graphs reveals that the intensity of the linking between action domains varies across groups.

The interventions under the responsibility of the regional transport department, for example, are more likely to belong to both the Environment and Competitiveness action domains, Fig.5a. Interventions by local public authorities, concern to a greater extent the Accessibility and Effectiveness areas, Fig.5c. When considering all the actors, finally, the Efficiency and Competitiveness areas share the greatest number of actions.

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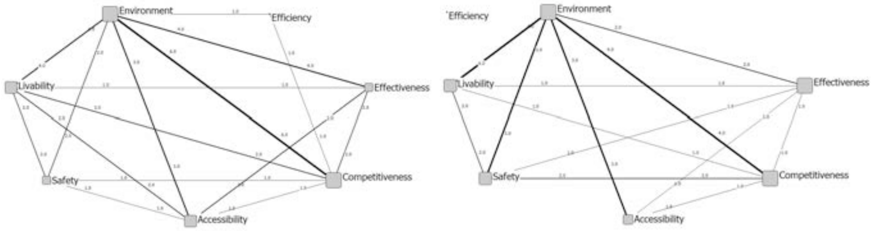

Fig. 5a Transport department (left) – Fig. 5b Regional departments (right)

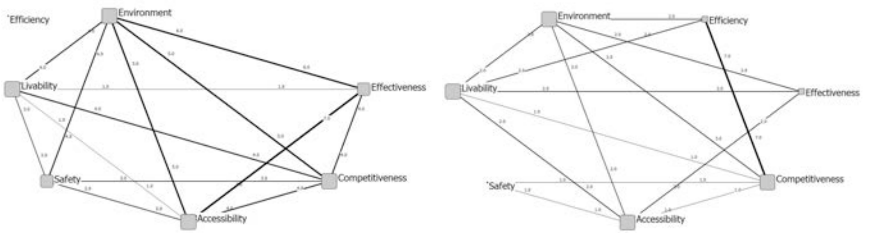

Fig. 5c Other public actors (left) – Fig. 5d All actors (right)
Fig. 5 Affiliation networks of plan's actions by actor groups in the Piedmont Mobility and Transport Plan

By simply summing up the data of the four affiliation networks an overview of the expected involvement of the actor groups can be obtained, as well as their influence in each action domain. The graphs in Fig. 6 illustrate the resulting configuration. They show that, not unexpectedly, each intervention area entails the participation of a certain variety of actor groups. The only exception, in this exercise, is for the Efficiency area in which only two actor groups are concerned. They also reveal that the actor group involving local public authorities is the most prominent, Fig.6a, affecting 37% of the total number of relationships between the intervention areas. As already shown by the affiliation network (Fig. 5c) the influence of this group is higher in the Accessibility and Effectiveness action domains. The transport department, the second most influential group, involves one out of four of the total number of cross-area relationships. Its presence is more relevant in the Environment and Livability action domains (Fig. 6b). The most diversified actor group which includes all the regional stakeholders has a major role when dealing with the interventions in the Competitiveness above all Efficiency area. Finally, the graphs show that regional departments have a greater responsibility for those actions concerned with Environment and Safety

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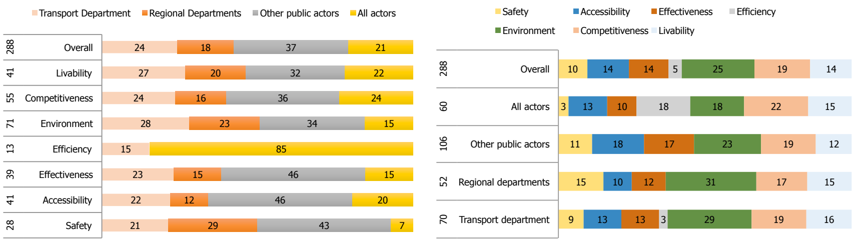

Fig. 6a Actor groups (left) – Fig. 6b Action domains (right)
Fig. 6 Percentage distribution of actor groups and action domains in the overall affiliation network (*)

(*) The numbers associated with the labels are the row and column totals of table representing the overall affiliation network.

5 CONCLUDING REMARKS

Drawing on current experience in the Piedmont region, this paper has examined some aspects of transport long-term planning and its challenges for sustainability-oriented policy practices. A claim was made that the transformations occurring in the reflexive dimension have a prominent role for sustainability. First, they are an invitation to critically revise the usual ways in which transport issues are conceived (the theoretical dimension), to think about how to set the necessary courses of action (the process dimension) and assess their achievements. Second, they require us to ascertain how we can know if our transportation system is becoming more or less sustainable and whether the policy measures adopted are achieving their intended goals (the reflexive dimension). Third, and even more importantly, they challenge us to develop, within our community, policy bundles that are more environmentally benign and conducive to a better quality of life.

The arguments give support to already accepted facts that to cope with long term sustainability issues it is necessary to create specific institutional capabilities and knowledge (Kemp & Loorbach, 2003; Kemp et al., 2011). At the conceptual level, they call for apparently diverse aspects such as: a. innovative thinking about how we, as technology savvy and responsibility-laden actors envision and legitimize a sustainable transport policy, and b. an enhanced ability to put projects into operation and see that their completion goes in the right direction. To the extent that awareness of the intangibility of the former and the physicality of the latter are gaining prominence in today's policy practices, the relevance of the question of how to connect the two becomes apparent. The flourishing literature about *city smartness,* in its various dimensions, contributes to such linking (Puron Cid et al., 2014). The meta-approach suggested here which entails the combined perspectives of continuous evaluation and direction-finding is one such contribution. It builds on the assumption that any planning effort meant to harness sustainability-climate changes has to leverage those reflexive activities helping create the conditions for the desired sustainability situations to occur (von Gansfwerveld's anticipation of the third type).

Of course in its current form, the meta-approach is a minimal framework for shaping thinking and its usefulness will have to be proven against concrete applications. To give some inklings of its potential, an exploratory exercise has been carried out which uses social network analysis to investigate the intervention areas of the Piedmont transport and mobility long-term plan. The analytic exercise made it possible to highlight the possible connections between plan's action domains as different types of actors may be involved in the realization of the interventions. More specifically it showed that all the selected actor groups have a role in contributing to the achievements of the plan's targets. Because of their institutional liability,

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however, some of them might be more influential in certain intervention areas and even make easier the packaging of a few actions across the areas (Givoni, 2014). Finally, the exercise suggests a few topics worth being addressed in the implementation of the Piedmont MTP and in the more general debate about sustainable development planning as well. First, it is evident that awareness of the innovative scope of the plan is still limited. To have an open and innovative context is an essential condition for the plan to be successfully rolled out in an effective and efficient way. Developing appropriate approaches to help actors make sense of the plan's orientations, causal relationships, and underlying values is therefore a main requirement (as for the local transport agency, for example, see the DISTILLATE experience in UK) (Hull, 2009). Second, as highlighted in the studies about adaptive policy, (Haasnoot et al., 2013; Marchau et al., 2009; Swanson et al., 2010; Walker, 2015), the original strategy of the MTP plan will have to evolve to account for the changes in the organization and socio-technical fabric of the Piedmont system. Consequently, plan's goals and pathways will have to be adjusted and require substantial efforts to consistently leverage the developmental evaluation and strategy formation perspectives (Booz Allen Hamilton, 2014). Finally, to make the policy mix more viable and socially acceptable, judicious bundles of elementary measures and strategies, so called *policy packaging*, are needed (Givoni, 2014). Although well accepted as a general concept, the notion remains vague in practice. For organizations with planning responsibilities, the possibility of devising or enabling a coherent action pattern (strategy), judiciously complemented with evidence about its social acceptability, costs, and benefits would greatly improve their ability to steer the transformations that they themselves can produce. To this end, the creation of a socio-technical environment in which a suite of ICT-based analytic tools, such as agent-based models and network analysis (Taeihagh et al., 2014) can be implemented, tested and discussed with the relevant actors is an effort worth being pusued.

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ECOSYSTEM SERVICES AND ECOLOGICAL NETWORKS

A CASE STUDY FROM FLANDERS

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ABSTRACT

Despite of ecosystem services are vital for humans, the ability of ecosystems to provide their services is threatened by urban development, industries, agriculture, and grey infrastructures. Europe is a highly anthropized continent, and the consequence of loss and degradation of natural spaces negatively affects ecosystems as well as the biodiversity. Currently, a structured framework of ecosystem services-based approaches is still lacking to improve planning policies. The aim of this paper is to investigate relations between ecosystem services and ecological networks, in order to define best practices in spatial planning, by discussing how spatial associations between ecosystem services and ecological networks could affect intrinsic peculiarities of the territory. Firstly, we address the concept of ecosystem services and ecological networks on the basis of a literature review; then, we focus on crucial relationships between ecosystem services and ecological networks. In particular, we study the case of the Flemish region, the most urbanized and populated area in Belgium. In this context, we analyze the presence of areas with a potential value for the ecosystem service of water purification into the ecological network of Flanders, in order to understand in which way planning approaches based on ecosystem services provided by the ecological network could be implemented into an ecological and sustainable view of development. We propose an approach that could represent the basis for a new research agenda able to recognize spatial associations of ecosystem services and the role of ecological networks as baseline for evolutionary ecosystem-based approaches in spatial planning.

KEYWORDS

Water Purification; Ecological Networks; Ecosystem Services; Spatial Planning

1 INTRODUCTION

Landscape transformation and contingent habitat loss are among the greatest threats to ecological integrity and ecosystem's health. Mitigation approaches used to deal with these pressures are related to the presence of ecological networks (ENs) within the transformed landscape. Quality of the ENs is of great importance for reducing human disturbance. ENs are significant for biodiversity conservation and for provision of ecosystem services which contribute to human well-being (Samways et al., 2010).

Unsuitable agricultural and forestry practices, pollution, infrastructure construction and urbanization are often cause of environmental impacts, ecosystems changes and fragmentation (Cannas & Ruggeri, 2016). Urban growth, severance by transport infrastructure and intensive agricultural land management threaten the context of ENs. In particular, agricultural uses affect soils and waters with nitrates, first among all nitrogen. Nitrogen is a key component of ecosystems and a major control for ecological conditions and functioning in the atmosphere, biosphere, hydrosphere and pedosphere (Breuer et al., 2008). Since the middle of the 18th century, due to the industrialization the development production of fertilizer, and the rapid increase in fossil fuel consumption for energy generation and mobility, the human population has significantly altered the global nitrogen cycle (Vitousek et al., 1997).

While nitrogen is beneficial for crop production, its excess act as pollutant. When too much nitrogen reaches water bodies, eutrophication can occur, and, with high levels, it can also adversely affect human health.

Nitrogen can be dispersed in the environment in different pathways and the excess pollute groundwater and surface water. In particular, nutrient leaching (as nitrate compounds), deriving from agricultural land, is one of the main contributes. For this reason, the reduction of nitrate leaching is a challenge in issues regarding important variable for denitrification in order to mitigate water pollution.

Ecosystems can provide a such service concerning water purification, which is an essential ecosystem service (ES) since we need water to survive. Nutrient excesses and other pollutants (e.g., metals, viruses, oils and sediments) are processed and filtered out as water moves through wetland areas, forests, and riparian zones. This ES provides clean drinking water and water suitable for industrial and recreational uses, and wildlife habitat (Penninghton & Cech, 2010).

ENs can help to improve the water purification ES by protecting and restoring ecosystems that provide these services.

In this paper we focus on the role of ENs providing water purification and involves the northern region of Belgium, the Flemish region (Flanders). Since Flanders are threatened by excesses of nitrates, especially from agricultural origins, we analyze the contribute to the water purification ES provided by ENs. In particular, by using the InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) software, developed by the Natural Capital Project[1], we take into account nutrient retention in ENs and their potential role to mitigate the presence of threatened areas by nitrates.

[1] This project is founded by: Woods Institute for the Environment and Department of Biology of Stanford University; Institute on the Environment of Minnesota University; Nature Conservancy; World Wildlife Fund (WWF). Retrieved from https://www.naturalcapitalproject.org. Last access June 2018.

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2 MATERIALS AND METHODS

2.1 STUDY AREA

The study area concerns the Flemish region, located in the north side of Belgium. This area adjoins: to the North and North-East with the Netherlands; to the North-West with the Ocean Atlantic; to the East with the France. The region has an area of approximately 13.600 sq.km.

Predominant land covers (LCs) are related to: grassland and crops, covering each one around 27% of the region; 10%, forest vegetation; around 15%, settlement; 3%, water; and the rest, around 16%, other kind of vegetation. The dominant land use (LU) is related to agriculture, concerning 46% of the region; 7%, nature conservation areas; 2% recreational uses; 27%, urbanized areas; and 1%, uses related to water; the remnant 17%, other kinds of land uses[2].

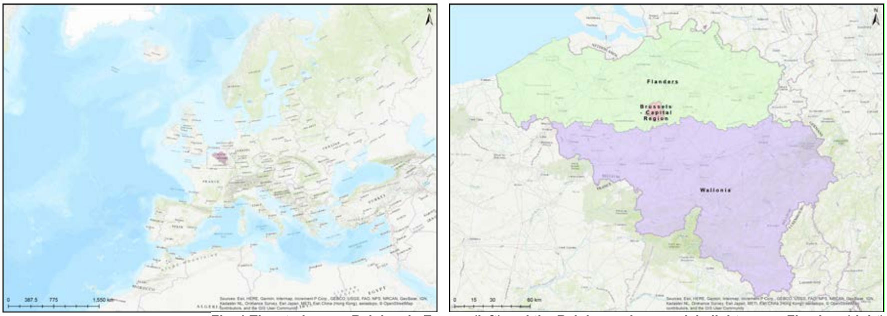

Fig. 1 The study area. Belgium in Europe (left) and the Belgian regions, and, in light green, Flanders (right)

2.2 ECOLOGICAL NETWORKS IN FLANDERS

In Flanders, there are two main ecological networks: the Natura 2000 Network (N2K), as per Habitat Directive[3], and the Flemish ecological network (VEN&IVON), as per Belgian law.

The N2K in Flanders consists of 62 sites; in particular, 24 sites of community importance (SCIs) and 38 special protection areas (SPAs). Furthermore, 5 marine sites, in the north of Flanders, are part of the N2K.

The national ecological network consists of two parts: the Flemish ecological network ([Vlaams Ecologisch Netwerk], VEN), which is a structure of areas where nature conservation policies are the main objective to be developed, and the Integral intervention and support network ([Integraal Verwevings- en Ondersteunend Netwerk], IVON), which is the surrounding support of the VEN. In turn, VEN consists of: Great units' nature ([Grote Eenheden Natuur], GEN) and Great units' nature in development ([Grote Eenheden Natuur in Ontwikkeling], GENO), which could be understood as core areas of the network. IVON consists of: Nature interrelation areas ([Natuurverwevingsgebieden], NVWG) and Nature connection areas ([Natuurverbindingsgebieden], NVBG), which could be understood as connective elements. Despite of the spatial definition of NVWG, NVBG has not been identified yet.

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[2] Retrieved from https://land.copernicus.eu/local/urban-atlas/urban-atlas-2012/view. Last access June 2018.

[3] Council Directive 92 /43 /EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31992L0043&from=EN. Last access June 2018.

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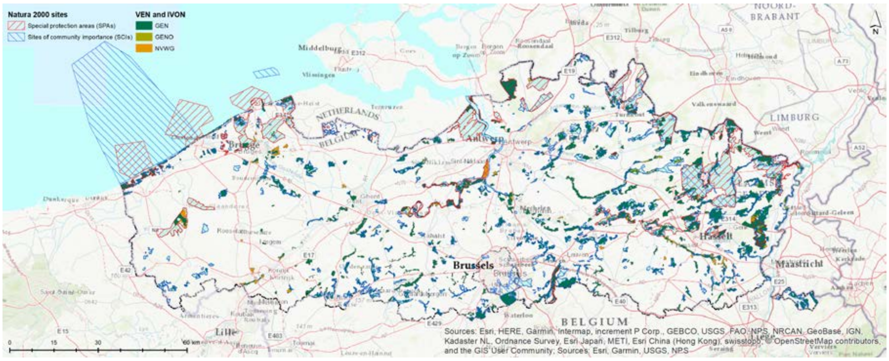

Fig. 2 The Natura 2000 Network and the Flemish ecological network

VEN and IVON are among important legal instruments of environmental policy that are shared with spatial planning policies. In this way, in Flanders, the nature is widely protected, and users and owners can directly participate to improve the environment. The Flemish ecological network covers 932,91 km^2, of which 638,67 km^2 (68.5%) are totally contained into the Natura 2000 Network, which covers 1686,54 km^2. The total amount of ENs in Flanders is about 1950 sq.km. Tab. 1 shows the percentage of surfaces of land use and land cover in ENs in Flanders; almost the 38% of the land use is for agriculture, very close to the global percentage of Flanders for agriculture.

LAND COVER	%	LAND USE	%
Agriculture	13.20	Agriculture	37.76
Bare soil	1.03	Nature conservation	44.15
Forest	29.83	Other	2.31
Grassland	26.11	Recreation	2.22
Heath	4.68	Urban	10.07
Other vegetation	9.38	Water	3.49
Swamp	4.00		
Tidal flats and saltmarches	0.42		
Urban	4.28		
Water	7.07		
	100		100

Tab. 1 Percentage of surfaces of land use and land cover in ENs in Flanders

2.3 THE CASE STUDY: ECOSYSTEM SERVICES IN FLANDERS. WATER PURIFICATION

ESs are a range of goods and services important for human well-being, generated by ecosystems (MA, 2005). They can be categorized into provisioning, regulating and cultural services, according to the CICES (Common International Classification of Ecosystem Services). The Directive 91/676/CEE ("Nitrate Directive") defines "pollution" as "the discharge, directly or indirectly, of nitrogen compounds from agricultural sources into the aquatic environment, the results of which are such as to cause hazards to human health, harm to living resources and to aquatic ecosystems, damage to amenities or interference with other legitimate uses of water". Moreover, the Directive 2000/60/EC, establishing a framework for Community action in the field of water policy, underlines that Community waters are under increasing pressure from the continuous growth in demand for sufficient quantities of good quality water for all purposes. Thus, the ES of water purification

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is crucial. In this section, we analyze the Flemish region with a focus on nutrients issues. Firstly, we analyze the presence of areas under critical conditions for nitrates (called “focus areas”); then, we elaborate the Nutrient retention map with the Nutrient delivery ratio (NDR) model of InVEST; finally, we combine those two elaborations with the presence of ENs, in order to identify critical conditions and potential resources from ENs aim to provide beneficial ESs.

Focus areas for nitrate concentration

On 1991, the Directive 91/676/CEE, concerning the protection of waters against pollution caused by nitrates from agricultural sources, introduced parameters in order to contain excesses of nitrogen. After that, other directives have been defined in the framework of water policy, also with the aim to confine the problem of pollution. In Flanders, crop and livestock production contribute for 49% of N, especially with fertilizer (Coppens et al., 2016). As consequence, since the context is threatened by excesses of nitrates, on 2006, a decree[4], concerning the protection of water against pollution caused by nitrates from agricultural sources, established to implement effective approaches to protect surface water and groundwater. In fact, this decree aimed to reduce water pollution due to nitrates and phosphates from agricultural sources and to prevent further pollution, according to the Directive 91/676/CEE. On the basis of the decree, since 2012, focus areas[5] related to water quality data are designated every year (as shown in Fig. 3 and Tab. 2). Focus areas are surfaces where the nitrate concentration[6] of 50 mg nitrate per liter in the surface water is exceeded or where the nitrate concentration in the groundwater does not show sufficient decrements. Focus areas are defined each year on the basis of the following criteria: new focus areas can be classed if an exceedance of pollution limits in the surface water is measured or if groundwater measurements do not decrease sufficiently; focus areas can be deleted if no exceedance is measured in the surface water and when the trend of measurements in groundwater is sufficiently low. Areas can lose the focus area status after two consecutive positive evaluations of both surface water and groundwater. Those areas have a bonus during the previous year, if exceedances do not occur in the surface water in the following winter season and if the trend of concentration in groundwater remains favorable, those areas may become no more focus areas.

Water purification as nutrient retention

In order to investigate potential nutrient retention in the context of Flanders, we apply a methodology grounded on the Nutrient Delivery Ratio (NDR) model of the InVEST software, which models the water purification ecosystem service by assessing nutrients retention for nitrogen and phosphorus. This model describes the movement of masses of nutrient through the space, and the steady-state flow of nutrients through empirical relationships, and, finally, maps nutrient sources from watersheds and their flows to the stream. It is based on the hypothesis that any element of the watershed is characterized by specific nutrient load and nutrient delivery ratio, which is a function of its upslope area and its downslope flow path.

[4] Retrieved from http://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=nl&la=N&cn=2006122232&table_name =wet. Last access June 2018. The decree is called “Manure Decree” [Mestdecreet] and have been updated on 2017.
[5] Data related to years from 2012 to 2018 are retrieved fom https://www.vlm.be/nl/themas/Mestbank/bemesting/ gronden/kwetsbare_gebieden/focusgebieden/Paginas/default.aspx, and they can be downloaded at: http://www.geopunt .be/catalogus/datasetfolder/1ff4bb09-77a5-4ba8-ab84-a54a2f698652. Last access June 2018.
6 As defined by the Nitrate Directive.

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Downslope flow is related to the retention efficiency of land cover (NCP, 2015). In this study, we consider only nitrates transported by the surface flow. The NDR model requires some inputs: a digital elevation model (DEM), obtained from European datasets7; a land cover map, elaborated from European datasets8; a shapefile of watersheds, elaborated with ArcHydroTools; a raster of potential runoff, elaborated with a kriging statistic tool by using data precipitation of Belgian rain gauges9; a biophysical table, containing fields where land covers are associated to nutrient loads and their efficiency retaining N. Here, the biophysical table is built including the presence of focus areas: we consider different parameters for areas not under focus and for focus areas; focus areas are intended to be overloaded by nitrates with a lower efficiency retaining N.

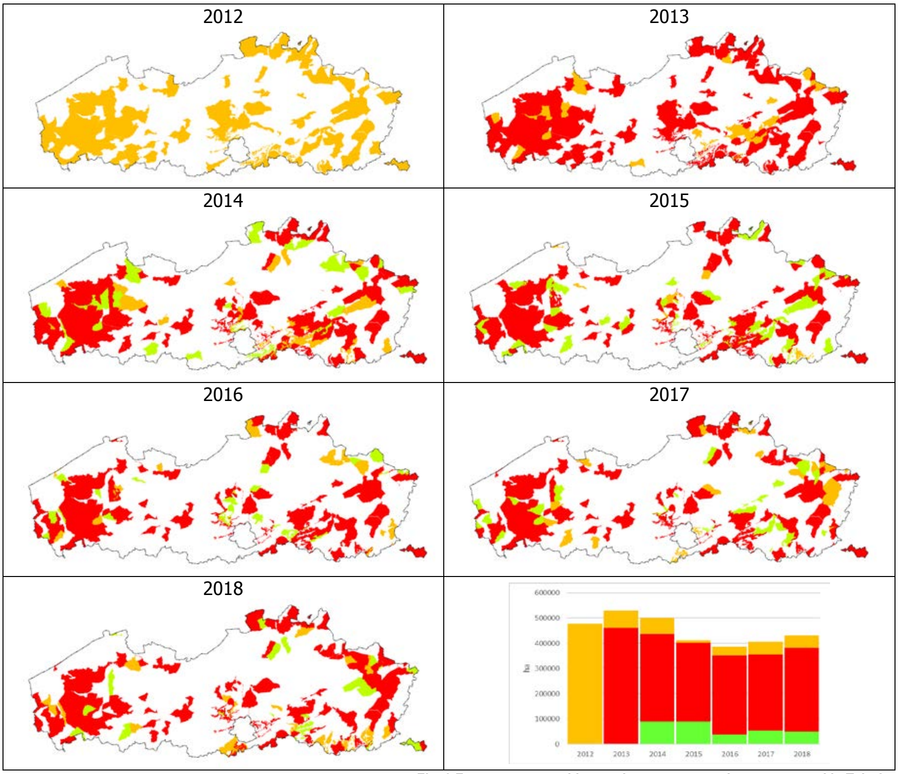

Fig. 3 Focus areas sensitive to nitrate concentration, as reported in Tab. 2

[7] Retrieved from https://land.copernicus.eu/pan-european/satellite-derived-products/eu-dem. Last access June 2018.
[8] Retrieved from https://land.copernicus.eu/local/urban-atlas/urban-atlas-2012/view. Last access June 2018.
[9] Retrieved from ftp://ftp.bafg.de/pub/REFERATE/GRDC/catalogue/grdc_stations.zip. Last access June 2018.

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	Surface [ha]			
	Focus area with bonus	**New focus area**	**Focus area from previous year**	**Total**
2012	-	477466	-	477466
2013	-	69655	461247	530902
2014	89657	64407	347031	501094
2015	89412	10357	312313	412082
2016	37792	34511	314552	386855
2017	52180	50692	303936	406809
2018	50429	49987	331102	431517

Tab. 2 Surface of focus areas sensitive to nitrate concentration

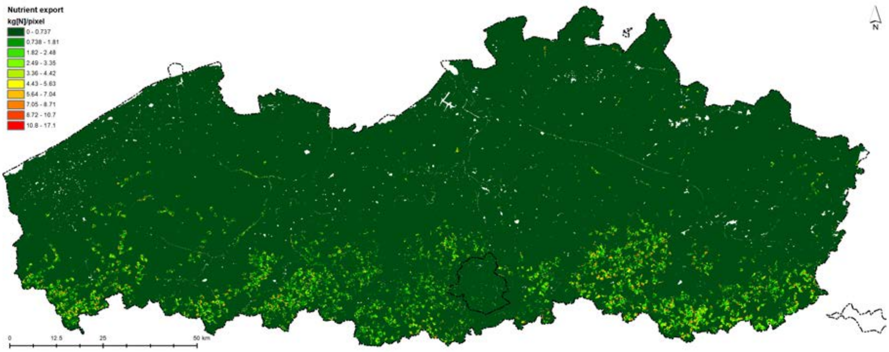

Fig. 4 Nitrogen export map for Flanders

Fig. 4 shows the nutrient retention map, as nitrogen export. Each pixel shows how much nutrient eventually reaches the stream. It indicates the potential contribution of soil and vegetation to purifying water: with green colours, there are low values of nitrogen export and the purification is higher; with red colours, there are high values of nitrogen export and the purification is lower.

<u>Water purification in ecological networks in Flanders</u>

When ecosystems slow the water down, forests, woodlands, wetlands, and natural grasslands act as sponges and water purification occurs. However, the presence of areas with nitrogen excess could negatively affect areas with high value for habitats and species and the service of water purification naturally provided by ecosystems.

Fig. 5 shows how much critical is this problem in Flanders: the total amount of focus areas in the Flemish region is 6357.89 sq.km., of which 951.66 sq.km. involve ENs, nearly the 50% of their surface. Although this, the contribute to ENs to nitrate retention is crucial. As shown in Fig. 6 and Tab. 3, the highest percentage of lower N export class involves more than the 95% of the surfaces of Flanders and ENs, but the highest N export classes principally involve surfaces outside ENs.

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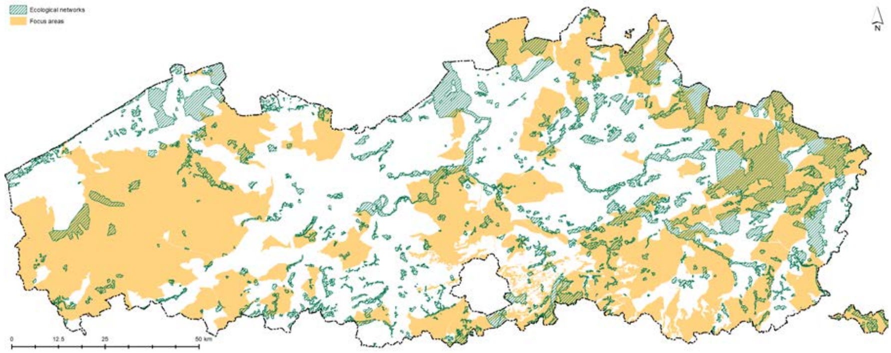

Fig. 5 The overlapping of focus areas and ENs in Flanders

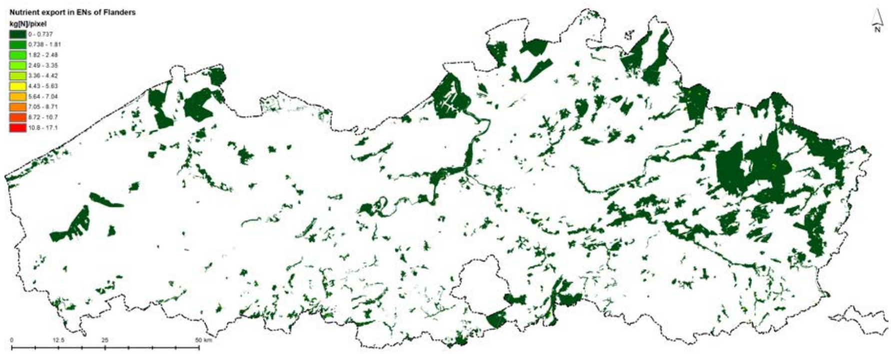

Fig. 6 ENs and potential nutrient retention in Flanders

	Flanders		**ENs**	
Classes kg[N]/pixel	Area [km^2]	%	Area [km^2]	%
0 - 0.737	13000.91	95.62%	1855.17	95.333%
0.738 - 1.81	123.20	0.91%	3.19	0.164%
1.82 - 2.48	187.92	1.38%	3.35	0.172%
2.49 - 3.35	99.15	0.73%	1.93	0.099%
3.36 - 4.42	50.89	0.37%	1.39	0.072%
4.43 - 5.63	29.82	0.22%	0.92	0.047%
5.64 - 7.04	18.65	0.14%	0.58	0.030%
7.05 - 8.71	10.78	0.08%	0.27	0.014%
8.72 - 10.7	7.18	0.05%	0.21	0.011%
10.8 - 17.1	3.93	0.03%	0.19	0.010%
	13532.42	**99.53%**	**1867.20**	**95.951%**
	Area of Flanders		**Area of ENs**	
	13596.06		1946.00	

Tab. 3 Percentages of surfaces of potential nitrogen export in ENs in Flanders

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3 CONCLUSIONS

Agricultural sources pollution has been listed as one of the leading sources of pollution in rivers and water bodies throughout the world. This pollution, which includes sediments, nutrients, and pesticides, can be transported from soil to surface waters via runoff events generated either by irrigation or natural precipitation (Zhang et al., 2010).

Nutrients pollution and eutrophication of surface waters is a crucial issue for our ecosystem. All waters, both superficial and underground, have the ability to react to direct and indirect loads of pollutants. This capacity, called self-purification, includes a complex series of mechanisms. They aim at reporting the water on its original state. However, if the intake of polluting substances is excessive, the self-purification capacity of water bodies is exceeded, so that phenomena such as eutrophication and/or chemical and microbiological contamination could be highlighted.

The Flemish region is particularly interested by the phenomenon of excess of nitrogen, as consequence of agricultural practices during the years. Consequently, in order to conform to European directives, areas with excess of nitrogen have been identified and are under steady control. These focus areas involve a large percentage of the Flemish surface, also threatening areas crucial for the presence of important habitats and species, like ENs. In this context, we have considered the role of ENs to provide ESs, in particular water purification. By building a layer of information including the presence of ENs, the areas mainly threatened by nitrates and the potential nutrient retention of the context, we could evaluate the condition of ENs.

Results demonstrate what was expected. Values within the ENs are particularly favorable compared to the percentage values found throughout Flanders. The threat posed by the widespread presence of the focus areas means that the value of the natural capital constituted by the ENs is even greater than the usual considerations related to their interest from the point of view of the protection of habitats and species.

For environmental planning, predicting nitrogen retention in surface flow is a complex task, as only few process studies are available. In fact, models of nitrogen retention quantification are either rather complex and require a high number of input data, that often are not available during the planning period, or models simplify the involved processes to the availability of data (Trepel & Palmieri, 2002). The concept of ecosystem functions, goods and services is a crucial instrument in planning processes, since it helps to identify and quantify benefits from ecosystems, and the full costs of their loss, and provides a communication tool to involve stakeholders in a constructive dialogue in this process (de Groot, 2006). In fact, when landowner decisions are based solely on market returns and their direct interests (without payments for ecosystem services), they tend to generate land use or land cover patterns with lower provision of ecosystem services and biodiversity conservation (Nelson et al., 2009). In fact, human perception, choices, and actions are often phenomena that drive political, economic, or cultural decisions that lead to or respond to change in ecological systems (Brunetta & Voghera, 2014).

By recognizing the role of ENs, the Flemish agency for nature and forests ([*Agentschap Natuur & Bos*][10]) defines several principles in order to protect and improve natural values which belong to ENs, like protection of existing landscape, limits for manure loads and pesticides, protection of all forests, moors, marshes, swamps, ponds and springs, and to maintain a sustainable manage of water resources.

[10] Retrieved from https://www.natuurenbos.be/beleid-wetgeving/beschermde-gebieden/ven-ivon/spelregels/basisbescherming-voor-natuur. Last access June 2018.

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The key to maintain the services of water purification is to protect and restore ecosystems that provide these services, so ENs, and to support proper planning that considers impacts on waterways as part of all urban, industrial and agricultural development: it is important for the current generation, and it is crucial to keep ecosystem services available for generations yet to come.

4 NOTES

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RESILIENT CRITERIA FOR STRATEGIC ROAD NETWORK

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ABSTRACT

In order to accommodate current needs of urban contexts and to define more resilient social-ecological systems, the research identifies the Emergency Plans as the most useful urban planning instruments to cope with these requests.
Particularly, these instruments seem to be the most effective ones to outline renovated risk management measures in order to determinate new planning models for more resilient communities.
Through them renewed conception and with special reference to seismic risk, there is a need to foresee both structural and functional intervention priorities on "strategic" territorial elements which are among current urban standards of greatest interest in planning today. Particularly, the paper identifies the strategic road network (i.e. the road infrastructures of connection between essential services and emergency areas) as the key element of the backbone of a resilient community. In this context, the paper stresses the need to evaluate in a planning phase the safest strategic road according to different features: from the seismic vulnerability of buildings facing it, to the redundancy due to existing alternative roads in emergency conditions, to the presence of critical elements.
Starting from these assumptions, future research will be directed towards resilient-based planning models (RDB), which can be considered as the next generation of performance-based design approaches (PBD) in order to evaluate better the interdependency among different elements of an urban system.

KEYWORDS

Resilience; Emergency Planning; Public Spaces

1 INTRODUCTION

One of the most current topics of debate in the sphere of territorial governance is linked to the evolution of the concept of urban planning standards. Consequent to the change and transition processes which the urban structure experiences and undergoes, over time the need to orient planning towards more qualitative expressions of public spaces capable of guaranteeing an opportunity corresponding to the real needs of the community, has emerged (Stella Richter, 2010). The traditional urban model of the last century, anchored to quantitative aspects, especially in the definition of services, is now outdated and the planning process has to be adapted to the new reality by providing appropriate integrations both between the different planning stages and between the different ordinary and specific instruments. In relation to this, the present contribution aims to propose priorities for defining new – yet already present – elements of the urban structure, which can be configured as fundamental parts of a renewed system of services that, as a set of spaces and of works, contributes to raising the levels of resilience in urban systems.

2 EMERGENCY URBAN STANDARDS

The definition of "urban standard" was born closely connected to the assignment of a series of indexes and limits on the basis of which to relate the spaces that characterize the urban construction (residential and commercial settlements). This basic concept has evolved over time both from a conceptual point of view and from a purely applicative point of view. Referring to the national context, the concept of "urban planning standard" was introduced in Italy with the law no. 765 of 1967, which addressed the need to stop the phenomenon of building speculation. However, it was in the subsequent Ministerial Decree 1444/68 that the limits and indexes proposed by the aforementioned law were set out. In the seventies, regional authorities took over at the legislative level, which differed little from the national guidelines on the definition of standards. Only later, have the Regions operated actively by introducing the concept of "qualitative" standard, as well as introducing complex programs. These programs, through a renewed form of public/private consultation, introduced "additional" standards. They have also overcome the problem of expropriations and reduced problems related to the lack of resources, committing the private sector to the creation of services. In light of this brief overview, we can state that today the concept of "standard" refers to the more general one of "services", in reference to which there is no single definition nor classification. The delivery of services can be associated with various areas, in relation to the increasingly articulated needs of the population residing in different areas and according to the different boundary conditions. In ordinary conditions of community life, the minimum allocation (from a quantitative point of view) and its performance characteristics (in terms of accessibility, full usability and security for any citizen, functionality and technological adequacy, management simplicity and economy, etc.) guarantee an increase in urban and environmental quality, and therefore a higher quality of life. On the other hand, it would be necessary to provide suitable public spaces and infrastructures useful not only in ordinary conditions, but also usable in the case of emergency, whatever type that may be. In this regard, the present contribution underlines the urgent need to define, as urban planning standards, three new categories of public facilities and infrastructures. These are emergency areas, namely safe areas to be reached and in which to stay in case of a disastrous event, strategic buildings, which are especially important structures for the territory and susceptible to overcrowding, and strategic road network, i.e. the infrastructures connecting strategic buildings and emergency areas. The introduction of this system of services facilitates numerous research

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ideas: who has the task of locating them on the urban territory? Is it necessary to develop new ad hoc instruments for their definition? And within which instruments? Which criteria should be followed for their identification? Which methods should be applied?

2.1 WHICH INSTRUMENTS?

One of the many tasks of urban planning is to determine new balances between the physical dimension of the city and the needs and requirements of the community (Angelucci et al., 2014).
An effective and efficient instrumentation system is the means by which to pursue these objectives, directing planning towards a more resilient perspective, in order to guarantee an appropriate management of territorial risks. The resilience of urban systems is connected to an ecosystem vision of the city, which does not necessarily imply the restoration of an initial state of efficiency following an immediate change, but certainly the achievement of a new state of equilibrium in terms of functionality through change and adaptation (Colucci, 2012), with sufficiently reduced recovery times and minimal negative consequences following the crisis (Bruneau et al., 2003). In line with what has been said, the present contribution identifies in the Municipal Civil Protection Plan (for the Italian case, or more generally the Municipal Emergency Plan) the instrument that can best contribute to the increase of urban resilience, especially in relation to the main phases of emergency planning, namely forecasting, prevention, relief and overcoming of the disastrous event. According to the literature and field experience, the first step to be taken is to precisely identify the three categories of standards mentioned above and make them a comprehensive part of a strategic system that is able to both maintain its essential functions unaltered during the emergency, and to recover its functions quickly once the emergency ceases. It must be said that, as it is currently conceived both as a principle and as a approach, the Municipal Emergency Plan, to date, is a tool that aims more to provide models for managing a crisis and determining responsibility for action, rather than for determining suitable methodologies for the prevention and mitigation of risks. In this regard, the identification of the strategic elements of the territory is only one of the new focal points of the Plan, as it, if appropriately accompanied by the correct definition of risk scenarios, at least allows the advance highlighting, even in ordinary conditions, of critical aspects that require public action to execute primary safety interventions. The scarcity of resources and public funding often constrains the operations of rehabilitation of structures and infrastructures: the definition of an urban strategic system that represents the backbone of a community (Bruneau et al., 2003) provides important indications on the priorities of action that must be planned and implemented by administrative bodies. Studies of literature on this subject propose two tools to verify the real functioning of urban settlements in case of emergency: the ELC (Emergency Limit Conditions), i.e. the structures and infrastructures that continue to guarantee their functionality, and the UMS (Urban Minimum Structure), that is the set of urban settlements able to ensure, both during the emergency and in the aftermath, the vital functions of the city. Following the criteria that determine the definition of the two structures, the contribution seeks to offer ideas for planning and appropriately identifying the strategic elements of a city, rather than verifying their correct identification a posteriori. Starting from this, the new general approach of the Plan should undoubtedly take a different form. In fact, the research identifies the need to draw up Guidelines that define in detail the minimum contents and their representation through procedures to standardize data so as to limit interpretation of information by users of the Plan. Secondly, the renewed emergency instruments must find the right comparison and a correct integration with the ordinary planning and territorial governance instruments that regulate the uses and the structures of the land at different levels of application. It is believed, indeed, that the choices of the municipal general urban plans

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(as well as any implementation procedures) must be defined also in order to improve urban behavior when an emergency occurs and, in turn, the definition of the new "rules" of emergency planning must take into account all the provisions of the municipal urban plan.

2.2 WHICH CRITERIA?

While it seems simple enough to identify the so-called strategic buildings (in Italy there is a Decree of the Presidency of the Council of Ministers that defines the structures of strategic interest: DPCM 2003/3685) and identifies areas of emergency in the territory (divided into waiting areas[1], areas of accumulation[2] and shelter areas[3]), it is still rather complicated to establish the strategic network of road infrastructures within a given city. It is easy to understand the importance of identifying safer connecting roads between a strategic structure and a waiting area. In fact, these are the safest paths for simultaneously directing: the population during an emergency in order to reach a safe place in which to wait for first types of comfort and rescue vehicles to help the affected population and to speed up their transfer to the nearest health facilities (included in the strategic structures). In this regard, the research seeks to start offering initial ideas for the definition of criteria for identifying the strategic road network, so as to attempt to quantify the increase in urban resilience generated by the application of this new planning methodology. Please note that all the criteria identified are representative of a single road in emergency conditions: therefore, no reference will be made to traditional performance parameters, status indicators relating to specific classes of functionality (Coni et al., 2005) nor functional characteristics on which estimates of the level of efficiency of a road infrastructure is based. In emergency conditions, in fact, the perfect regularity of the road surface nor the low level of noise generated by the road surface during the transit of means of transport does not assume binding importance, but rather the ability of an infrastructure to be safely useable by transport by users who must reach the emergency area from the building and vice versa. The definition of the level of practicability must therefore be based on the following parameters:

- presence of interrupted road sections. This parameter is assessed on the basis of an analysis of the vulnerability of the buildings facing the given road and the calculation of the overall area of the debris generated by the collapse of these structures on the basis of a fixed project earthquake. If even in a single road section the collapse of the buildings facing it would make it impossible to move to a general rescue vehicle (minimum width of 2 m), the infrastructure will be considered non-viable. The methodology for defining this first criterion is taking shape in the GIS environment thanks to a series of

[1] Waiting areas: places of initial reception for the population; squares, open spaces, car parks, public or private spaces not subject to risk (landslides, floods, collapse of adjacent structures, etc.) can be used, which can be reached via a safe route. The number of areas to be chosen depends on the accommodation capacity of the available spaces and the number of inhabitants. In these areas the population receives initial information about the event and are provided with the first types of comforts. The Population Waiting Areas will be used for a period of time between a few hours and a few days.

[2] Recovery areas for rescuers and resources: safe areas with respect to the different types of risk, where rescuers and the resources necessary to ensure rational intervention in the places affected by the event will have to find suitable accommodation. These areas must be easily accessible through safe routes, even with large vehicles, and located near water, electricity and with the possibility of disposal of wastewater. The period of emergency stay in these areas is between a few weeks and a few months.

[3] Reception areas or population shelters: areas safe from the various types of risk situated near water, electricity and sewer systems, where the first settlements are installed to house the affected population. They must also be easily reachable by large vehicles to allow them to be set up and managed. Accommodation facilities (hotel, residence, camping, etc.) are also included in the definition of reception or shelter areas

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algorithms elaborated in Python code that, with an automated process, will enable the decision maker to gather information on the viable paths and not of a given road network in case of seismic event;

- length of the road. This is a useful parameter for a maximum forecast of travel time: the shorter the road is, the more users can reach the desired point faster;
- width of the carriageway. This is a useful parameter for defining the capacity of a road: the wider this is, the more users can circulate safely;
- reference users. This is a parameter linked to the population density that will use the road;
- presence of critical elements. It depends on the number of elements that could be a source of fragility for the system (e.g. bridges, tunnels, bottlenecks, underpasses, etc.);
- number of sections affected by hydrogeological risks This is a parameter that can be calculated with risk papers provided by specialized bodies. In the Italian case it is possible to gather information on this subject from the overlap between the road network and the Hydrogeological Structure Plan;
- redundancy. This is a parameter linked to the possibility of having alternative routes to that road: if the road chosen as strategic is interrupted, it is still possible to reach the desired point in another way. Furthermore, redundancy is one of the universally recognized dimensions for increasing the resilience of a territorial system (Bruneau et al., 2003).

Once the above parameters have been defined, it will be possible to calculate, for each internal road in the municipal area, a Strategic Vulnerability Index for which, for now, a general definition formula is provided. Among the various alternatives of connection between a given strategic building and the nearest emergency area, the one with minor I_{sv} will be chosen as the strategic road.

$$I_{sv} = \Sigma w_i P_i$$

where:

I_{sv}=Strategic Vulnerability Index

w_i= weight of the i-th parameter, to be defined in relation to the importance and the impact of the single criterion

P_i= i-th parameter

3 FROM PERFORMANCE-BASED APPROACHES TO RESILIENCE-BASED MODELS

Urban planning, in recent times, is moving from an old traditional model that tended to "standardize" individual projects to a common strategy (conforming model) towards a new one that is more strategic and oriented towards "performance-based" approaches (Rivolin, 2008). This last model of planning, among other things, recognizes the impossibility of guaranteeing the total security of every single component of the urban system in any situation, but admits that there are acceptable levels of risk (or performance) to be defined (Staniscia et al., 2017). Therefore, it is believed that the definition of new emergency standards and the additional considerations proposed in this paper can be a useful contribution to direct research towards "performance-based" planning models. It is also noted that the proposed methodology tends to move towards more advanced approaches called "resilience-based", in contrast with traditional "performance-based" approaches (Cimellaro, 2016). Normally, in fact, the latter consider the performance of the individual elements as indicative parameters: it must be said, instead, that the performance of a single urban component does not depend exclusively on its efficiency levels, but is strictly linked to the functionality of all the other components that belong to the same urban system. Let us take the case, as an example, that after an earthquake an entire city is razed to the ground and that only one building in the city has no significant

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damage: according to the performance-based models, the status of the individual building is acceptable because it could still perform the functions for which it was designed; from the point of view of urban resilience, however, this is not true, because the entire urban system with which it interacted previously no longer exists. In relation to this, then, the importance of assessing the interdependence between the different elements of the territory becomes vital: in order to better cope with emergencies, it is not only important to consider the damage suffered by the single structure or infrastructure, but it is necessary and essential to evaluate the ripple effects that are generated after a catastrophic event and which, instead, are not visible in ordinary periods. This is the modus-operandi according to which we are working, for example, for the definition of Parameter No. 1, which involves an analysis of the interaction between urban settlements and the road system. The future developments of this research, therefore, will continue along this path, aiming, among other things, to propose methods for quantifying urban resilience, and helping to compare the real advantages that the proposed new planning model offers in relation to the traditional planning model.

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INCLUSION OF ECOSYSTEM-BASED APPROACHES IN THE REGULATIONS OF MARINE PROTECTED AREAS

AN EXPERIMENTAL PROCEDURE DEVELOPED IN SARDINIA. PART 1

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ABSTRACT

Spatial policies play a preeminent role in preserving green and blue infrastructure, whose favourable conservation status is crucial to deliver a wide range of Ecosystems Services (ES). However, given the variety and complexity of factors that interact in environmental processes, targeted policies and single-issue instruments demonstrated to have limited effectiveness on current major environmental challenges. Consequently, the harmonisation of sector-specific policies is indispensable to outline a long-term holistic vision, able to adequately deal with these issues. Nevertheless, many of the spatial policies implemented to date often lack of orderliness and consistency. For this reason, the GIREPAM (Integrated Management of Ecological Networks through Parks and Marine Areas) project, aims at improving and innovating management tools of marine-coastal areas and defining common transboundary integrated management strategies. Among the various activities of the GIREPAM project, a key role is played by the ongoing process of definition of an experimental procedure (Protocollo Sperimentale, PS) aiming at formulating appropriate regulation for the management and control of the MPAs named "Tavolara – Punta Coda Cavallo" and "Isola dell'Asinara" located in northern Sardinia. Essential part of this process is the here illustrated identification of issues that recur in MPA regulations and their discussion with MPA directors to define a methodology to include ES into the process of definition of MPA regulations, as explained in the second part of the contribution.

KEYWORDS

Marine Protected Areas, Ecosystem-based Approaches; Integrated Management; Biodiversity Conservation

1 INTRODUCTION

The steep rise in academic publication on the inclusion of Ecosystem Services (ES) in contemporary planning discourses shows the increasing need of considering them when reasoning on human–nature relations (Arkema et al., 2015). Notwithstanding, the transition from scientific research to real-world management decisions is far from being reached (Gomes et al., 2018). To date, even though ES have been extensively mapped, their inclusion in land-use plan definition and in environmental assessment is little experienced (Lai, 2016). A significant barrier to this goal is constituted by the contrast between two viewpoints that guide the assessment of ES: the anthropocentric approach, which implies strong economic evaluation of ES in relation to human utility, and the conflicting ecocentric approach which evaluates ES intrinsic biological value (Gomes et al., 2018). The simplistic "transference of benefits/values" suggested by Costanza (1997) has to be avoided, because it "demonstrate[s] a static vision of the ecosystem, which is not suitable for management situations" (Elliff et al., 2015). Marine and coastal zone shelter a great variety of ecosystems, but, since one-third of humans live in coastal areas, this ecosystem richness is currently threatened by a severe anthropogenic pressure, which is causing ES degradation, biodiversity and habitat loss (Ferreira et al., 2017; Ilman et al., 2016; Montefalcone et al., 2015; Parravicini et al., 2013; UNEP, 2006). Consequences of this degeneration are not restricted to environmental problems, but directly impact human well-being as well, as demonstrated by climate change and by significant drops in food provisioning (UNEP, 2006). Therefore, Marine Protected Areas (MPAs) are committed to overturn ecosystem and biodiversity loss, while supporting local economy based on sea and coastal resources (Paoli et al., 2018). Nonetheless, MPAs are often considered as a tool for fisheries management rather than for ecosystem management (Dalton, 2004). In this regard, a new conservation paradigm, which incorporates ES within protected areas planning rules, as suggested by the Strategic Plan for Biodiversity 2011-2020 and the related Aichi Targets, needs to be included into the sets of the biodiversity conservation measures (Leone & Zoppi, 2016).

This paper considers major challenges arisen during the analysis of MPA regulations and Natura 2000 management plans in force in the Sardinian areas of "Tavolara - Punta Coda Cavallo", "Isola dell'Asinara" and "Capo Carbonara –Villasimius" and those reported by the key actors of the management practice within the GIREPAM (Gestione Integrata delle Reti Ecologiche attraverso i Parchi e le Aree Marine – Integrated Management of Ecological Networks through Parks and Marine Protected Areas) project, specifically developed with the aim to improve and innovate management tools for marine-coastal areas, coherently with a holistic territory vision in the attempt of ensuring favourable conservation status of habitats, thus preserving biodiversity.

The paper is structured as follows. The next section describes natural protected areas in Italy and their legal framework. The third section defines the methodological approach and provides information on the case studies, analysing MPA key aspects to identify the unresolved issues to which the research is contributing. The fourth section reflects on the way public administrations have interpreted the concept of integrated approach to sustainable development in relation to MPA regulations. The last section draws conclusion and provides directions for future research. Moreover, the here defined analysis process and the methodological approach illustrated in the second part of the paper are intended to constitute a reference model for similar contexts in which the inclusion of ES would greatly enrich MPA regulations in order to adequately safeguard biodiversity.

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2 PROTECTED AREAS BETWEEN CONSERVATION AND ECONOMIC DEVELOPMENT

Models of natural protected areas, currently represent a fundamental tool for biodiversity conservation and ES preservation (Hoffmann et al., 2018). They incorporate natural resources in a holistic governance system in which MPAs and Natura 2000 sites play a preeminent role. MPAs are appointed a series of duties such as the monitoring and control of human activities and marine uses, the promotion of the recovery of exploited marine resources, the conservation or restoration of habitats and biodiversity, and the management and enhancement of ecosystem services including food production, water purification, or recreational activities (Leenhardt et al., 2015).In Italy, the underlying legislation for MPAs is constituted by the National laws no. 394/1991 and 979/1982, which provide a general legal framework for natural areas and regulations for marine protection, respectively. Furthermore, the Decree of the Environmental Ministry no. 394/1991 establishes Italian MPA denomination and demarcation, as well as their conservation objectives. According to the environmental value, it is possible to distinguish the following three levels of protection within the boundaries of an MPA: "zone A", where restrictions on use are the most stringent of the entire MPA, "zone B", where restriction on use are less stringent with respect to zone A, but still quite rigorous and "zone C", where recreational and fisheries activities are regulated, nevertheless allowed (Marino, 2011).

An additional model of protected areas is constituted by Natura 2000 sites, which consists of two kinds of sites: Special Protection Areas (SPAs), designated according to the Birds Directive, Council Directive 79/409/EEC on the conservation of wild birds and Special Areas of Conservation (SACs), which are adopted by the Member States after having been selected from lists of Sites of Community Interest (SCIs), according to the provisions of the Habitats Directive, Council Directive 92/43/ECC (Wallström, 2001). In particular, the Birds Directive is the oldest piece of EU legislation on nature conservation. It recognises the social, cultural, economic and environmental benefits of the hunting of wild birds, though highlighting the need for a form of sustainable hunting in order to not jeopardize the conservation efforts for the species (EC, 2016a). Since 1994, all SPAs are included in the Natura 2000 ecological network, set up under the Habitats Directive 92/43/EEC, which aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements by safeguarding the Natura 2000 ecological network against potentially damaging developments (EC, 2016b).

SPAs, SACs and SCIs cover 19% of the Italian land territory and almost 4% of the marine area overall and, in some instances, they overlap MPAs (MATTM, 2018). Conservation objectives are pursued through the regulation on organisation and execution of the MPAs and the management plans of SPAs and SCIs, but the variety and complexity of factors that interact in environmental processes requires the harmonisation of their contents according to a wider political framework for maritime spatial planning in order to outline a long-term holistic vision able to reduce conflicts between sectors, create synergies between activities and ensure adequate safeguard of habitats and species. However, many of the policies implemented to date often lack of orderliness and consistency, because they neither are mutually complementary nor establish synergy with the other planning tools in force (Gurrutxaga San Vicente & Lozano Valencia, 2009). In Italy, the difficulty of balancing environmental protection policies with developing policies led to a problematic interaction among national, regional and local governments that, rather than stimulating the desired growth, caused substantial economic loss. The consequent implementation issues determined a purely virtual management which demonstrated not being able to neither preserve protected areas nor improve economic local conditions (Fedele, 1998).

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3 INTEGRATED MANAGEMENT OF COSTAL AREAS: THE CASE STUDIES OF "TAVOLARA - PUNTA CODA CAVALLO", "ISOLA DELL'ASINARA" AND "CAPO CARBONARA" IN THE GIREPAM PROJECT

The proposed research is based on environmental and economic sustainability considerations, which, together with the analysis of the environmental context, represent the key concepts of the here illustrated models of MPA governance. Indeed, the coexistence of tourist, commercial and fisheries activities need multidisciplinary and integrated public policies (Navarro Ortega, 2014). Consequently, MPAs are expected to efficiently manage and protect vast areas characterised by the presence of precious habitats, but, since substances and forcing factors are efficiently transmitted throughout the highly connected marine system (Kelleher, 1999), managing protected areas as isolated reserves, without integrating them into wider spatial strategies, exposes them to the consequences of habitat alteration and destruction, pollution and overfishing that might occur outside their boundaries (Salm et al., 2000). Hence, the need to activate innovative planning processes that harmonise the various management tools in force in the area. For this reason, among the various activities of the GIREPAM project, from which this reflection originated, a key role is played by the ongoing process of definition of an Experimental Procedure (in Italian: Protocollo Sperimentale, PS) aiming at defining a pioneering approach to integrate the conservation measures, identified by Natura 2000 network for Special Protection Areas (SPAs) and Sites of Community Importance (SCIs), as well as the provisions determined by the Integrated Coastal Zone Management (ICZM) and by the Standardised Actions for the Effective Management of MPAs (ISEA - *Interventi Standardizzati di gestione Efficace in Aree marine protette*) protocols into the prospective Regulation of the MPAs. Indeed, in the three case studies analysed, namely "Tavolara - Punta Coda Cavallo", "Isola dell'Asinara" and "Capo Carbonara – Villasimius", both ICZM and ISEA protocols are adopted by the considered MPAs and both SPAs and SCIs are located within their boundaries, as shown in Fig. 1.

4 METHODOLOGY

Methodology of this first paper is articulated according to the flowchart shown in Fig. 2. The first phase is constituted by the identification of the case studies, which ends with the choice of the MPAs of "Tavolara - Punta Coda Cavallo", "Isola dell'Asinara" and "Capo Carbonara" due to their peculiarities and the willingness to collaborate of their management teams that made them the ideal examples to analyse. Once the MPAs for the study are selected, their respective regulations are analysed to identify recurrent major themes that underline their structure, while interviews and technical meetings are held with the key actors of the management practice and of the decision-making process in order to distinguish primary critical aspects in MPA management and regulation and to outline possible forms of inter-institutional cooperation. This phase of analysis leads to the definition of the critical issues related to an effective and efficient MPA management from which the need for a new methodological approach to integrate ES assessment into SEA originates.

4.1 ANALYSIS OF THE MPA REGULATIONS IN FORCE

The analysis of the regulations of the three MPAs studied identifies three macro-themes that underlie the definition of their sections. In particular, all the three regulations aim at preserving, conserving and protecting biodiversity, consider the overlap with other models of protected areas and promote sustainable development.

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Fig. 1 The MPAs "Isola dell'Asinara", "Tavolara – Punta Coda Cavallo", "Capo Carbonara" in Sardinia

Biodiversity preservation, conservation and protection are fundamental goals of the three MPAs and are entrusted to a series of conservation measures specifically formulated for each zone of the MPA characterised by a distinct level of protection on the basis of the assessment of the conservation status of habitats and species. In order to reach these objectives, access to the MPA is strictly regulated and even forbidden in some areas; introduction, removal and alteration of flora and fauna severely prohibited as well as shell and sand collection. In addition, recreational activities and lighting are in some cases limited and regulated in order to not cause harm to the local fauna. As reported in paragraph 3 and as illustrated in Fig. 1, both ICZM and ISEA protocols are adopted by each MPA studied and Nature 2000 sites are located within their boundaries. This means that different models of protected areas overlap, so that it is necessary to coordinate the various governance regimes according to a holistic vision of the territory to create a consistent and coherent network of protected areas able to ensure favourable conservation status of habitats, thus preserving biodiversity.

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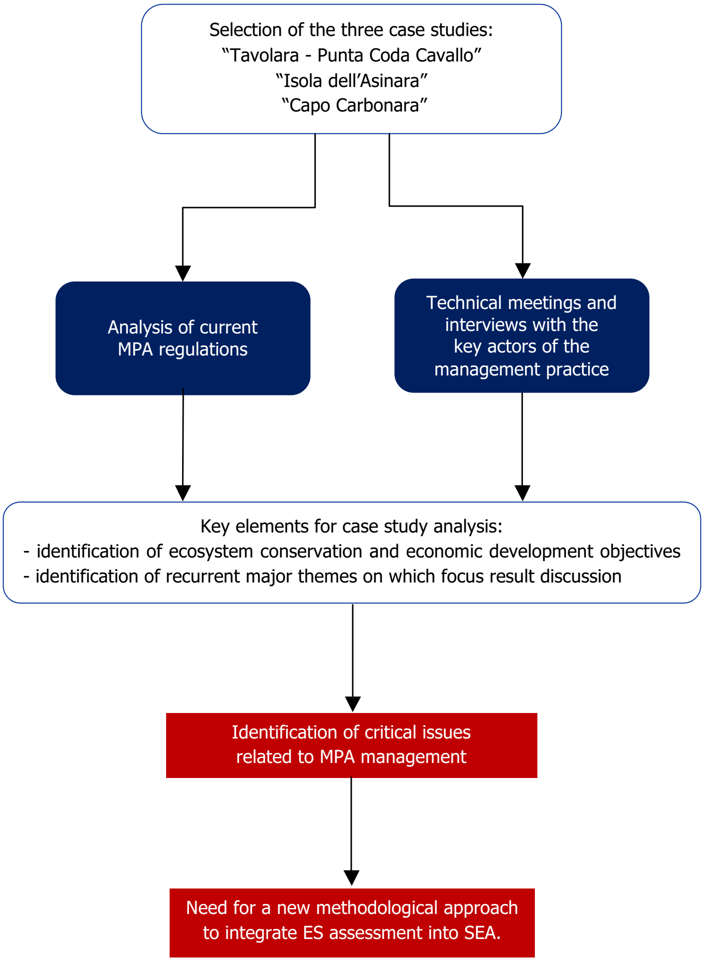

Fig.2 Conceptual model of the methodology

In each MPA multiple tourist, commercial and fisheries activities coexist, thus demanding multidisciplinary and integrated policies able to outline a long-term holistic vision, which meets present needs without compromising the ability of future generations to meet their own needs. For this reason, each MPA regulation presents a number of articles specifically addressed to every economic or recreational activity so that resource exploitation is disciplined and negative impacts on habitats and species are limited.

4.2 MEETINGS WITH THE KEY ACTORS OF THE MANAGEMENT PRACTICE

Technical meetings and interviews with the key actors of the management practice are focused on the following three aspects: MPA management issues, MPA management strategies and inter-institutional

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cooperation among the various public and private bodies involved in the decisional process and management practice of the MPA. During the interviews, each aspect has been introduced to the interviewee through the posing of a pertinent question as illustrated in Tab. 1.

ASPECT	QUESTION
MANAGEMENT	Which are the major critical points related to the MPA management, related to the economic, environmental safeguard and regulative aspects?
INTER-INSTITUTIONAL COOPERATION	How and to what extent the inter-institutional forms of cooperation can deal with the highlighted critical aspects, and which approaches are desirable in order to improve these forms of collaboration?
STRATEGIES OF INTERVENTION	Which aspects of MPA regulations should be more effective?

Tab.1 Questions posed to interviewees.

With regards to the management aspect, the main critical issue that surfaced from the technical meetings and interviews are the financial constraints that MPAs have to face yearly, due to the lack of funds the national government allocates to them. Consequently, the only solution to finance safeguarding and protection activities is to get European funds, which are allocated through highly competitive calls for project proposals, so that getting them is anything but easy. Another crucial problem is the implementation of national decrees and regulations in the various MPAs, because they do not consider the profoundly different socio-economic contexts. It seems that the future of the MPAs strongly depends on decisions taken by the Ministry offices, which have no cognizance of the peculiarities and specific needs of each territory. In addition, conflicts of jurisdiction often occur among the diverse levels of government. For example, in some administrative procedures, the competent authority is the Ministry itself and not the MPA manager, as one would expect. Thus, it is necessary to develop effective inter-institutional communication and collaboration among the key actors of the administrative sphere and of the numerous economic sectors that rely on healthy marine and coastal resources and that would benefit from improvements in the management practice and from a more equitable and efficient allocation of financial resources. Another example of jurisdiction conflict concerns imposition and collection of monetary sanctions. Indeed, the authority that has to ensure compliance with environmental regulations in force is rarely unambiguously identifiable, due to the fact that definition of the nature of violation (administrative, civil, or penal) is often missing. Consequently, surveillance and control are often inadequate so that illegal, unreported and unregulated economic activities are frequently undertaken especially in the surroundings of the MPA, outside of the boundaries controlled by the MPA authority. All the surveyed key actors agreed in stating that policy efficiency is strictly connected to the delicate communication and cooperation among the various players involved in the MPA management.

Concerning the strategies of intervention, some key actors raised the idea that MPA regulations would benefit from an economic assessment of MPA natural resources, which would add to the material value of activities developed within the MPA, the cost of potential environmental impacts that might affect the intrinsic biologic value of the resources themselves.

5 DISCUSSION AND CONCLUSION

There is clear evidence that MPAs management needs to properly balance environmental protection with economic development (Vietti & Tunesi, 2007). It follows that management practices have to be oriented to the increase of the environmental heritage thanks to an adequate balance between resources exploitation

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and protection. This paper highlights not only the preeminent role of ES in human existence, but also the crucial impact of conservation policies to enhance their quality through the preservation of environmental heritage. Thanks to an adequate management which integrates ES in MPA regulations, environmental heritage becomes an opportunity to foster economic development. Evaluation of environmental resources might be based on an anthropocentric or ecocentric approach. In the first case, ES are considered according to traditional market mechanism, while in the second case nature investment in terms of natural resources involved for service conservation is calculated regardless of the opportunity of benefits to mankind (FederParchi, 2014).

The paper reveals that, in each area examined, ecosystem preservation clashes with the demand for natural resources exploitation sought by the various local productive activities and by the tourist sector, so that enhancing economic performance while not impacting unacceptably on habitats and species is the main challenge an MPA Regulation has to face. Therefore, considering Regulation impacts on ecosystem services is crucial to achieve this ambitious purpose. In order to adequately assess both positive and negative possible effects of the Regulation on the environment, it is essential to include relevant information of ecosystem services into the process of definition of MPA regulations. This incorporation is perfectly feasible thanks to the existing procedure of the Strategic Environmental Assessment (SEA) (Geneletti, 2011) even though no methodological reference is traceable in the literature yet (Slootweg & van Beukering, 2008). The second part of the paper tries to fill this gap by elaborating a methodological approach to integrate ES assessment into SEA.

NOTES

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INCLUSION OF ECOSYSTEM-BASED APPROACHES IN THE REGULATIONS OF MARINE PROTECTED AREAS

AN EXPERIMENTAL PROCEDURE DEVELOPED IN SARDINIA. PART 2

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ABSTRACT

The preservation of natural ecosystems has assumed increasing importance in spatial planning, so that it is now considered essential to ensure sustainable spatial development. However, finding the right balance between local development and environmental protection might be a thorny problem for public administrations. For this reason, innovative and efficient tools are necessary to properly evaluate alternative options. Among these tools, Ecosystems Services (ES) have been calling the attention of scientific researchers in the last years, since the ES assessment might constitute a straightforward way of definition of sustainable development models.

In this study, a methodology to include ecosystem-based approaches in the definition processes of the regulations of Marine Protected Areas (MPA) is proposed in order to successfully preserve the singularly precious and vulnerable marine ecosystems, starting from the results of the analysis conducted in the first part of the contribution. The conceptual and methodological approach proposed involves the use of ES that are specifically tailored to both define regulations contents and assess regulation performances, thus supporting decision-makers in addressing environmental issues through an effective governance of the MPAs. The cognitive contribution is both empirical and methodological, since the study defines the regulations of two Sardinian MPAs and the proposed methodology is exportable into extra different protected areas in order to support planning processes oriented to the management of the environment as a holistic complex system of resources.

KEYWORDS

Marine Protected Areas; Ecosystem Services; Natural Capital; Strategic Environmental Assessment

1 INTRODUCTION

Starting from the results arisen in the first part of the paper, this second part aims to propose a methodological approach for the inclusion of ES into MPA regulations, through their assessment and mapping, in order to increase the information level constituting the background knowledge for the creation of more efficient management tools. In this sense, Natural capital assessment is recommended in order to overcome the current uncertainty in MPA management.

Natural capital is defined as "the world's stocks of natural assets which include geology, soil, air, water and all living things" (WorldForum, 2017). In the last decades, the importance of Natural capital for human well-being has been largely investigated by scientific researchers, highlighting the need of including its assessment into planning and programming tools in order to reverse the downward trends in European biodiversity and ecosystems conservation (Leone & Zoppi, 2016). In fact, the considerable modifications of the biosphere that have characterised the XX century, and that continue nowadays, affect both the socio-economic system and the human wellness.

For these reasons, the Italian law 221/2015 on *Environmental measures for promoting green economy and limiting the excessive use of natural resources* (so-called "Collegato Ambientale", i.e. Environmental Annex to the Stability-Financial Law) has established the institution of an Italian Natural Capital Committee (INCC), which is appointed to annually report on the State of Natural Capital in Italy. The Report collects environmental data in the form of physical and monetary units and "*ex ante* and *ex post* assessment of the effects of public policies on Natural Capital and Ecosystem Services". Both contents aim at encouraging public administrations to adopt environmental accounting systems in their programming and control activities. In particular, the Report highlights the inadequate conservation level of natural capital within coastal and marine zones, where the high level of "non-good" status waters and the high pressure on hydric resources (such as biotic resource withdrawal, contamination and invasive allocthonous species introduction) affects marine ecosystems and biodiversity (Worm et al., 2006).

Even though MPAs play a key role in the marine biodiversity conservation, in Italy they have very often been established with respect to landscape rather than to ecological criteria. Nevertheless, Italian MPAs hold habitats and species characterised by high biodiversity. Given that, it is necessary to guarantee an adequate MPA management in order to preserve this natural richness (Blasi, 2011).

The capability of coastal and marine ecosystems for providing ES is threatened by the conflicts that emerge among the different ecosystem uses, and by the various human activities established and developed in seaside settlements. MPAs can efficiently harmonise socio-economic uses and environmental preservation, while reducing conflicts among stakeholders (Addis et al., 2011).

The paper is structured as follows: section 2 presents a brief literature review about Natural Capital, ES and their importance in marine and coastal zones. In section 3, the methodological proposal for the inclusion of ES assessment and mapping into Marine Spatial planning (MPS) is illustrated. Section 4 discusses the results and draws comprehensive conclusions from the two parts of the paper.

2 THE IMPORTANCE OF ES IN MPA PLANNING

Among the interactions between natural elements, ecosystem functions are those with the potentiality "to provide goods and services that satisfy human needs, directly or indirectly" (De Groot, 1992). Ecosystem Services (ES) are the benefits that people obtain from ecosystem functions, as the "temporary storage of

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flood waters in wetlands, long-term storage of climate-altering greenhouse gases in forests, dilution and assimilation of wastes by rivers” (Costanza, 1997).

Through the analysis of ES benefits and the assessment of their detriment in terms of economic and environmental costs, an adequate level of sustainability in defining development strategies can be reached (Elliff & Kikuchi, 2015). For this reason, including ES into the decision-making process for natural space planning and management is considered crucial.

Marine and coastal ecosystems provide the largest amount of ES (Costanza, 1997), despite experiencing one of the largest anthropic pressure, and being consequently affected by a worrying decline of ecological function (Leenhardt et al., 2015). Therefore, it is decisive to consider them in the light of the multiple uses existing in marine territories (Guerry et al., 2012), in order to understand which ecosystems are the most vulnerable and jeopardised because of an excessive exploitation that does not consider their “resilience and carrying capacity limits” (Elliff & Kikuchi, 2015).

Given these considerations, MSP appear strategical in order to support the sustainable use of marine and coastal resources. Indeed, MSP can perform the important function of managing the natural contrasts existing among economic goals and ecosystem conservation. MSP can also support and regulate ES provision (Ivarsson et al., 2017). In order to achieve these goals, a deep knowledge of ecosystem structure and function is needed for the design of adequate maritime spatial plans (Ivarsson et al., 2017).

The importance of MSP is recognised by the EU, which has emanated the Maritime Spatial Planning Directive (MSPD, Directive 2014/89/EU) and the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC). Even though an ES approach is specifically defined in the latter, the two Directives do not adequately consider ES in their implant (Ivarsson et al., 2017).

The paper suggests a methodology to assess and map ES within MSP, by integrating them into the Strategic Environment Assessment (SEA) process, in consideration of its capacity to integrate socio-economic aspects with the analysis of the biophysical environment.

Indeed, SEA can efficiently guide and support the design of MPA Regulations, since its “ultimate aim […] is to help to protect the environment and promote sustainability […] by helping to integrate environmental (or sustainability) issues in decision-making” (Therivel, 2004). This inclusion can also improve the potential and quality of SEA (Geneletti, 2011).

3 A METHODOLOGICAL PROPOSAL FOR INTEGRATING ES INTO SEA

In this section, a methodological proposal for the integration of ES assessment into SEA is proposed. As outlined by Geneletti (2011), “a standard and internationally accepted procedure does not exist for SEA, even though some key common stages can be identified”. Consequently, this study moves from the guidelines of the Sardinia Regional Administration for the SEA of Municipal plans. Among the SEA phases proposed by the guidelines, the environmental analysis is a fundamental part, as it “represents the preparatory act for the environmental assessment” of the planning tool which is being designed. The environmental analysis means to identify natural resource conditions and to assess anthropic pressures being exerted on them, in order to underline possible critical points in environmental terms. With this aim, a set of environmental components are identified, namely i) air; ii) water; iii) waste management; iv) soil; v) biodiversity of flora and fauna; vi) landscape and cultural and historical heritage; vii) settlement layout and demography; viii) economic and productive systems; ix) mobility and transport; x) energy; xi) noise.

The analysis is synthetized in a technical form, reporting each component with a brief description and its qualification and quantification through suitable indicators.

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This paper proposes the inclusion of ES assessment and mapping into the SEA by establishing a new environmental component named "Ecosystem Services". According to the MPA peculiarities, the most appropriate types of ES are chosen and included into the component. ES are briefly described through indicators, as showed in Table 1.

ECOSYSTEM SERVICES	
Ecosystem services' (ES) are the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing: that is, the benefits that people derive from functioning ecosystems (Costanza et al., 1997; MEA, 2005).	

PROVISIONING	
Provisioning services: all nutritional, material and energetic outputs from living systems. In the proposed structure a distinction is made between provisioning outputs arising from biological materials (biomass) and water. The consultation confirmed the classification of water as problematic, because it was regarded by some as primarily an abiotic, mineral output. The majority argued, however, that it should be included among ES convention and wider usage of the notion of an ecosystem services also suggests that it is appropriate to do so. In addition, water bodies of all scales host communities of species that provide ecosystem services themselves (Haines-Young & Potschin, 2013).	
Fibers and other materials from plants and algae	
Harvest of materials for direct use or processing	[t/yr./km^2]
From: … Year: …	
Wild fish and their outputs	
Landings	[t]
Catch Per Unit Effort	[CPUE; t]
From: … Year: …	

REGULATING AND MAINTENANCE	
Regulating and maintenance: covers all the ways in which living organisms can mediate or moderate the environment that affects human performance. Therefore, It covers the degradation of waste and toxic substances by exploiting living processes; by reconnecting waste streams to living processes it is in this sense the opposite of provision. Regulation and maintenance also covers the mediation of flows in solids, liquids and gases that affect people's performance as well as the ways living organisms can regulate the physico-chemical and biological environment of the mankind (Haines-Young & Potschin, 2013).	
Stabilisation and control of erosion rates	
Shoreline erosion rate	[mm/yr./sq.km]
Fonte: … Anno: …	
Buffering and attenuation of mass flows	
Trends in numbers of damaging natural disasters	[%]
Sediment accumulation rate	[cm/yr.]
From: … Year: …	
Hydrological cycle and water flow maintenance	
Soil water storage capacity	[mm/m]
Floodplain water storage capacity	[mm/m]
From: … Year: …	
Maintaining habitats	
Submerged and intertidal habitats diversity	[Nr./sq.km]
Species distribution	[sq.km/sq.km]

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From: … Year: …	
Pest control	
Presence of alien species	[Nr.]
Distribution of alien species (sq.km).	[sq.km]
From: … Year: …	
Chemical condition of salt waters	
Nutrient load to coast	[t/yr.]
Heavy metal and persistent organic pollutant loading.	[t/yr.]
From: … Year: …	
Climate regulation by reduction of greenhouse gas	
Carbon stock and sequestration	[Mg/ha]
From: … Year: …	

CULTURAL SERVICES

Cultural Services: covers all the non-material, and normally non-consumptive, outputs of ecosystems that affect people's physical and mental health. The consultation suggested that this area was particular problematic in terms of the different terminologies used by the wider community, which often does not make a distinction between services and benefits. For example, the term recreation is, , particularly problematic in this respect. We also note that all services, whether they are provisioning or regulating can have a cultural dimension. However, it is valuable to retain the section for Cultural services, and to maintain the two categories as separate (Haines-Young & Potschin, 2013).	
Scientific	
TV programs, studies, books etc. featuring sites and the surrounding area, scientific articles and patents.	[Nr./yr.]
From: … Year: …	
Educational	
Environmental educational events.	[Nr./yr.]
From: … Year: …	
Heritage, cultural and symbolic	
Heritage and cultural sites	[Nr.]
Extent of marine protected areas	[sq.km/ha]
From: … Year: …	
Aesthetic	
Visitors to sites	[Nr./yr.]
Amount of nature tourism	[Nr./yr.]
Pictures	[Nr./yr.]
From: … Year: …	

The output of the environmental analysis is a SWOT analysis conducted for each component, drawing the information from the analysis of the environmental component data. The SWOT analysis highlights positive and negative factors within the examined area, and allows to define the objectives of environmental sustainability that constitute the guide for the formulation of the planning tool actions.

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4 DISCUSSION AND CONCLUSIONS

The proposed inclusion of ES into the environmental analysis, by creating the new environmental component called "Ecosystem Services" empowers the flexible character of SEA, which is adaptive to the context where the planning process is conducted (Geneletti, 2011). ES assessment and mapping can improve the capacity of "providing support to decision processes undertaken under conditions of uncertainty and scarcity of information" (Geneletti, 2011). Moreover, the proposed ES approach contributes to take steps towards bridging the gap represented by the scarce ES consideration during decision making and elaboration of public policies (Costanza et al., 1997).

The ES approach appears particularly suitable and decisive for marine and coastal area management, which increasingly needs integrated and holistic strategies (Elliff & Kikuchi, 2015). In fact, as the environmental analysis leads to the construction of objectives that pursue environmental sustainability, including ES in the analysis can efficiently and successfully "clarify the potential impacts of strategic decisions on the state of ecosystems and their services, so as to avoid unintended negative consequences and seize opportunities for improvement" at a very early stage of the planning process (UNEP, 2014).

Therefore, the aim of MSP of promoting sustainable usage of marine resources through the conciliation of safeguarding marine ecosystems and support socio-economic needs (Ivarsson et al., 2017), can lead to the "opportunity to formally mainstream ecosystem services into decisions at the strategic level" (Geneletti, 2011). Finally, the proposed integration of ES into the SEA meets the EU Biodiversity Strategy 2020 (EU, 2011) call, oriented to the implementation of the mapping and assessment of the state of marine ecosystem services (MAES). In future research, the proposed methodology can be applied and tested to practical case studies, such as the three MPAs mentioned in the first part of the paper, in order to improve the making process for the design of MSP and MPA regulations. Moreover, regulation effectiveness and capacity to deal with the issues about the recurrent themes arisen in both the interviews and the technical meeting with the MPA managers can be underscored through an accurate assessment of their performances.

NOTES

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Maddalena Floris and Salvatore Pinna have made substantial contributions to the conception and design, background and concluding remarks of the paper. The first and the fourth sections have been jointly written by the authors. Salvatore Pinna has taken care of the second section. Maddalena Floris has taken care of the third section.

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SPREADING GREEN INFRASTRUCTURE-RELATED BENEFITS

A STUDY CONCERNING SARDINIA, ITALY

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ABSTRACT

The European Commission defines green infrastructure (GI) as a network having the Natura 2000 sites at its core, able of delivering numerous ecosystem services (ESs), and "strategically planned", emphasizing the role of GI as regards the integration of ecological connectivity and protection of the environment, and ecosystems multifunctionality.

In this study we build upon a methodology applied in a previous study (Lai and Leone, 2017), where a Sardinian regional GI was identified based upon four factors: conservation value, natural value, recreation value and landscape value.

Once a regional GI is identified, we comparatively assess the eligibility of areas located inside and outside protected areas to be part of the regional GI on the basis of the four factors indicated above.

We find that patches located in protected areas are comparatively more eligible to be part of the regional GI than patches located outside only as far as conservation value's spatial distribution is concerned. In the other three cases, the behavioral patterns of patches located inside and outside protected areas are less clear-cut. Policy recommendations coming from the outcomes entail the mitigation of land-taking processes, the enlargement of the Natura 2000 Network, the detailed and analytical identification of landscape goods, and the enhancement of the accessibility to attractive sites.

KEYWORDS

Green Infrastructure; Ecosystem Services; Natura 2000 Network; Environmental Planning

1 INTRODUCTION

The Communication of the European Commission "Green infrastructure: enhancing Europe's natural capital" defines a GI as a "strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue, if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings" (European Commission, 2013). Integrating the identification and management of GIs within planning policies represents a key issue with particular reference to the European Landscape Convention (Liquete et al., 2015). As Hansen and DeFries (2007) argue, planning tools in protected areas aim at building an integrated ecosystem by establishing noteworthy ecological and socio-economic relationships with their neighboring areas. Moreover, according to various authors (Gaston et al., 2006; Ruiz Benito et al., 2010), assessing spatial policies concerning protected areas could improve efficiency and effectiveness of environmental protection measures and of related management measures.

In our view, the identification and planning of a regional GI can be conceived as a significant tool to extend the positive impacts of environmental conservation policies beyond the boundaries of protected areas. Rural areas and urban green spaces are indeed to be included within a regional GI (Spanò et al., 2017; Wickham et al., 2010). Building upon the methodology developed by Lai and Leone (2017), who identify a regional GI in relation to four values conservation value (CONS_V), natural value (NAT_V), recreation value (RECR_V) and landscape value (LANDS_V)), our study aims to assess the suitability of areas to be included in the regional GI based upon the above mentioned four values in case of both unprotected and protected areas. In particular, CONS_V accounts for the presence of habitats of community interest, identified under the provisions of the Directive no. 93/43/EEC, also known as "Habitats Directive". NAT_V takes into account the capacity of biodiversity to provide ecosystem services. RECR_V accounts for the relationships between landscape attractiveness and areas where people spend their leisure time. LANDS_V takes into account the presence of landscape assets as defined by the Italian Code on cultural goods and landscape (Law enacted by decree no. 2004/42). Under this perspective, the definition of a holistic planning approach that integrates the relationships between the regional GI and protected areas can support and strengthen spatial planning policies to enhance the capacity of ecosystems to provide services. This study comprises four sections. The methodological approach is described in the second section. The outcomes are presented in the third section and discussed in the fourth, which also provides final considerations and directions for future research.

2 MATERIALS AND METHODS

Sardinia is an Italian island characterized by a significant presence of protected areas - around 19% of its land mass (Fig. 1). The Sardinian regional administration approved a Regional Landscape Plan (RLP) in 2006; such plan does not provide any reference to a regional GI. In this study, we apply the methodological approach developed by Lai and Leone (2017), where a regional GI is defined and mapped through four values (CONS_V; NAT_V; RECR_V; LANDS_V) that reflect the landscape's multifunctional nature. In particular, CONS_V, calculated following the approach developed in a regional report (CRITERIA & TEMI, 2014a), takes non-null values in areas characterized by the presence of habitats of community interest, and it is computed as follows:

$$\mathrm{CONS\_V} = P*(R+T+K)$$

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where P accounts for the presence of priority habitats listed in the Annex II of the Habitats Directive, R assesses the rarity of each habitat in relation to its occurrences within the Sardinian Natura 2000 standard data forms, T accounts for threats, and K assesses current knowledge on each habitat based on the results of a regional monitoring report (CRITERIA & TEMI, 2014b). CONS_V can take values in the [0-21] interval. NAT_V was computed and mapped through the "Habitat quality" model of the open source software "InVEST". The model requires different input data, such as land use/land cover map, a list of threats to habitats and their spatial distribution, a vector map defining accessibility to sources of degradation, the suitability of each land cover type to be considered as habitat and its sensitivity to each threat, and a half-saturation constant.

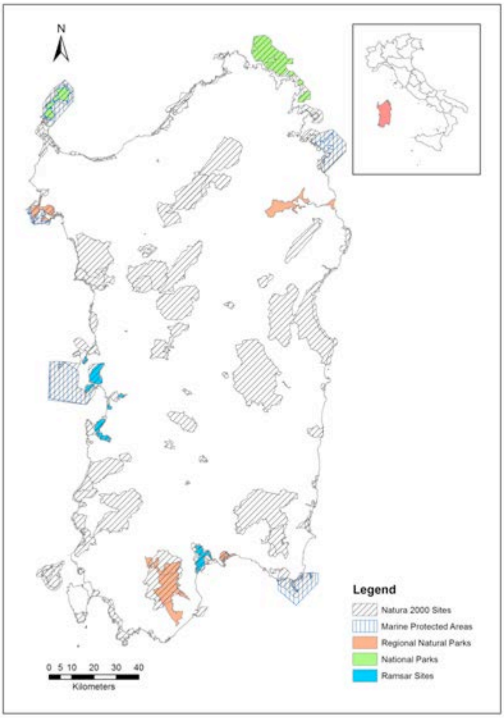

Fig. 1 Study area. Source: own work

RECR_V was computed and mapped through the "Visitation: recreation and tourism" model of InVEST, which, by using data provided by the social media Flickr, in each cell of the study area calculates the total number of pictures uploaded by a single user in a single day between 2010 and 2014. LANDS_V accounts for the significance of landscape assets in relation to the strictness of RLP's rules. All of the four values, normalized in the [0-1] interval, were mapped and summed through GIS techniques. As a result, the total value (TOT_V) can take values within the [0-4] interval. In order to evaluate if and to what extent the four values influence the suitability of areas to be included in a regional GI, within or outside protected areas, we classified the Sardinian land mass into two macro-categories: natural protected areas (consisting of national and regional parks, Natura 2000 sites and Ramsar sites), and the rest of the region (hereinafter,

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"unprotected areas"). TOT_V values were arranged into tertiles. Moreover, in relation to both protected and unprotected areas, for each tertile of TOT_V, and for each of the four values, we estimated areas taking null values and we calculated their percentage in relation to the total area of the macro-category in the specific tertile and assessed the mean of CONS_V, NAT_V, RECR_V and LANDS_V.

3 RESULTS

Fig. 2 and Tab. 2 provide the results of the analysis. In particular, Fig. 2 shows the spatial distribution of TOT_V on the left and the spatial distribution of each x_V (CONS_V, NAT_V, RECR_V and LANDS_V) on the right.

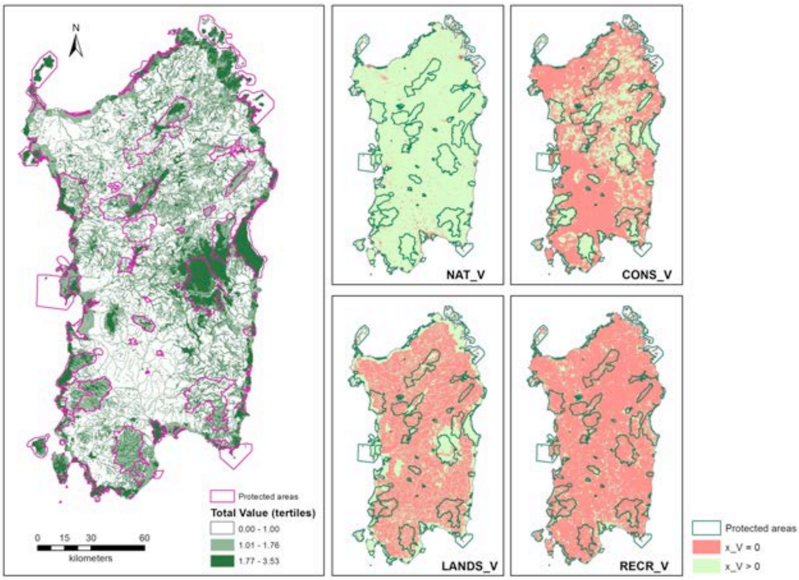

Fig. 2 To the left: Total value (TOT_V), i.e. suitability of each land parcel to be part of a regional GI (tertiles), also showing the boundaries of protected areas. To the right: spatial layout of the four values; superimposed are the boundaries of protected areas. Source: own work

Tab. 2 reports, for each macro-category and for each of the four values in relation to each tertile of the total value, the following indicators: mean value, number of patches taking the null value, percentage of such patches with respect to the total number of patches in the corresponding tertile, total area of patches taking null values and the percentage of these areas with respect to the total area included in the corresponding tertile. Natural protected areas show steadily increasing values of the mean between the first and the third tertiles in the case of CONS_V, RECR_V and LANDS_V, while NAT_V's mean decreases from 0.55 to 0.47, when switching from the first to the second tertiles. The highest percentages (in terms of both number of patches and area) of patches taking null values correspond to LANDS_V and RECR_V in the first and second tertiles, and CONS_V and RECR_V in the third tertile. NAT_V shows a low presence of patches taking null values in terms of number of patches and their percentage, and percentage of areas. This can be clearly observed for the percentage of areas with null values, which equals 2.19%, 2.18% and 0.23% in the first, second and third tertiles, respectively.

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			CONS_V	NAT_V	RECR_V	LANDS_V
Natural protected areas (467,635.13 ha)	1st tertile: TOT_V = [0 - 1] (94,150.93 ha)	mean	0.13	0.55	0.002	0.11
		no. patches x_V = 0	17,366	4,526	23,944	24,401
		% patches x_V = 0 (*)	63.34	16.51	87.34	89.01
		total area x_V = 0 [ha]	87,332.79	2,063.00	89,766.74	93,097.17
		% area x_V = 0 (**)	92.76	2.19	95.34	98.88
	2nd tertile: TOT_V =]1 - 1.57] (148,548.90 ha)	mean	0.25	0.47	0.017	0.57
		no. patches x_V = 0	16,661	20,482	24,064	20,825
		% patches x_V = 0 (*)	33.99	41.78	49.09	42.48
		total area x_V = 0 [ha]	30,961.17	3,244.88	123,262.52	120,388.14
		% area x_V = 0 (**)	20.84	2.18	82.98	81.04
	3rd tertile: TOT_V =]1.57 - 3.53] (224,935.30 ha)	mean	0.34	0.89	0.024	0.95
		no. patches x_V = 0	21,452	2,102	44,796	2,741
		% patches x_V = 0 (*)	24.41	2.39	50.98	3.12
		total area x_V = 0 [ha]	45,805.20	509.24	160,293.70	9,970.11
		% area x_V = 0 (**)	20.36	0.23	71.26	4.43
Unprotected areas (1,940,665.60 ha)	1st tertile: TOT_V = [0 - 1] (1,015,579.00 ha)	mean	0.08	0.53	0.005	0.05
		no. patches x_V = 0	132,144	22,824	129,865	157,793
		% patches x_V = 0 (*)	79.62	13.75	78.25	95.08
		total area x_V = 0 [ha]	963,608.81	50,825.56	940,178.56	999,186.97
		% area x_V = 0 (**)	94.88	5.00	92.58	98.39
	2nd tertile: TOT_V =]1 - 1.57] (563,063.30 ha)	mean	0.15	0.60	0.012	0.61
		no. patches x_V = 0	73,136	15,193	67,584	43,224
		% patches x_V = 0 (*)	64.27	13.35	59.39	37.98
		total area x_V = 0 [ha]	271,474.10	21,355.85	448,720.03	328,386.09
		% area x_V = 0 (**)	48.21	3.79	79.69	58.32
	3rd tertile: TOT_V =]1.57 - 3.53] (362,023.30 ha)	mean	0.24	0.86	0.019	0.96
		no. patches x_V = 0	40,890	868	64,398	2,338
		% patches x_V = 0 (*)	43.43	0.92	68.41	2.48
		total area x_V = 0 [ha]	198,254.15	1,134.46	305,528.38	17,732.95
		% area x_V = 0 (**)	54.76	0.31	84.39	4.90

x_V= (CONS_V, NAT_V, RECR_V, LANDS_V)
(*) percentage of patches with x_V=0 with respect to total number of patches in the corresponding tertile
(**) percentage of areas with x_V=0 with respect to total area included in the corresponding tertile

Tab. 1 Mean value, number of patches taking the null value and their percentage with respect to the total number of patches in the corresponding tertile, total area of patches taking null values and their percentage with respect to the total area included in the corresponding tertile for each macro-category, for each tertile and for each of the four values

In addition, although the highest percentages of areas taking null values correspond to RECR_V (95.34%; 82.98%; 71.26% between the first and the third tertiles), the maximum value pertains to LANDS_V (98.88% in the first tertile). Still looking at the percentages of areas taking null values, CONS_V has a very high value in the first tertile, and moderate and similar values in the second and third tertiles. In relation to unprotected areas, the mean and the percentage of patches taking null values show an opposite trend. For each x_V, the former always increases and the latter gradually decreases (except for RECR_V), when switching from the first to the second and third tertiles. As for the percentage of patches taking null values, although the highest values correspond to RECR_V (78.25%, 59.39% and 68.41% in the first, second and third tertiles,

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respectively) and to CONS_V (79.62%, 64.27% and 43.43% in the first, second and third tertiles, respectively), the most significant variation from the first to the third tertile pertains to LANDS_V, which decreases from 95.08% in the first tertile to 2.48 in the third. Still looking at the percentage of patches taking null values, the lowest values correspond to NAT_V (13.75%, 13.35% and 0.92% in the first, second and third tertiles, respectively). The percentage of areas taking null values shows a similar trend to that described for the percentage of patches, the only exception being CONS_VAL and RECR_V, which show a fluctuating trend when switching from the first to the second and third tertiles.

4 DISCUSSION AND CONCLUSIONS

The results of this study show rather high mean values in the third tertile of the total value and lower mean values with reference to the first and second tertiles for NAT_V, both in case of protected and unprotected areas. Moreover, as for NAT_V, the percentage of areas taking null values does not exceed 5% in both the two macro-categories. In order to strengthen the suitability of a patch to be included in the Sardinian regional GI, the outcomes related to NAT_V suggest two types of plan actions for both the two macro-categories. The first concerns patches taking non-null values, with particular attention to the first or to the second tertile. Its mean shows similar values in case of both protected and unprotected areas, ranging between 0.4 and 0.6. The rather low values of the mean suggest considerable scope for improvement. Two issues should be addressed within spatial policies: first, the mitigation and/or elimination of threats through the implementation of specific actions, such as soil restoration in sealed soils, regeneration of undergrowth and monitoring of pasture and grazing land; second, the mitigation of land-taking processes and of land cover transitions spurring qualitative degradation (Lai et al., 2017a, 2017b), since the quality of land cover is the main factor that influences NAT_V. In relation to CONS_V, for each of the tertiles, the mean takes significantly higher values in protected areas than in unprotected areas. Moreover, the quite low value of the mean as regards the first tertile reflects the high percentage of patches taking the null value, which exceeds 90% of the total area both in protected and unprotected areas. The percentage of areas taking null values is fairly lower as regards the second and third tertiles than in the first tertile both in protected and unprotected areas, even though in the second macro-category the percentage is twice as that in the first. As a consequence, extending the environmental protection regime concerning habitat and species beyond Natura 2000 sites can represent an effective policy recommendation to strengthen the suitability of patches to belong to the regional GI. In fact, in the study area, some Natura 2000 sites coincide with the other protected areas here analyzed (national and regional parks and Ramsar sites), where conservation measures related to Natura 2000 sites are already in force. This, taking also account that the size of protected areas is around a quarter of that of unprotected areas, suggests that policy and planning actions should focus on additional measures to maintain and protect habitats and species. In addition, extending conservation measures beyond the boundaries of the Natura 2000 sites requires, on the one hand, advancement of scientific knowledge concerning habitats and species outside the Natura 2000 sites, and, on the other hand, lobbying activities towards the national government and the European Union to enlarge the Natura 2000 Network. With regard to LANDS_V, the third tertile is characterized by the small total size of areas taking the null value whereas the first tertile shows an opposite situation both in case of protected and unprotected areas. Indeed, the area of patches taking null values constantly increases when switching from the third to the second and first tertiles in the two macro-categories, although in the second tertile the percentage of areas taking null values is comparatively higher in the case of protected areas. These data suggest that landscape assets are mainly located within unprotected areas. In order to strengthen the suitability of a

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patch to be included in the Sardinian regional GI, planning actions should focus on the identification of landscape assets both in protected and unprotected areas, which requires a close cooperation in terms of co-planning procedures between local municipalities, the Sardinian regional administration and the national Ministry of cultural goods and activities, and of tourism. In fact, the status of protected landscape asset can be acquired as a result of the procedural process established in compliance with the Italian Code on cultural goods and landscape. As for RECR_V, all of the tertiles are characterized by high percentages of areas taking null-values (above 70%) both in protected and unprotected areas. However, unprotected and protected areas show an opposite trend when switching from the second to the third tertile. In fact, the share of areas taking the null value is higher in unprotected areas in relation to the second tertile and higher in protected areas as regards to the third tertile. With reference to the second tertile, a possible explanation concerns differences in the environmental protection regimes in force: since in unprotected areas access is not restricted, the probability of visitors posting images increases. In relation to the third tertile, the larger number of images posted can be justified by the attractiveness of protected areas. As a result, the outcomes of our study suggest no evidence of a correspondence between the suitability of patches to be part of the regional GI and recreational attractiveness in both protected and unprotected areas. On the other hand, as pointed out in a recent study (Cannas et al., 2018), attractiveness represents a factor that significantly influences the inclusion of patches in the Sardinian regional GI. Moreover, due to its volatile nature, recreational value requires further specific insights to be implemented in future research. In conclusion, the proposed methodology can be applied to other Italian and European regional contexts. Indeed, Natura 2000 sites are identified by all Member States under the provisions of the Habitats and Birds Directives, and, despite different national institutional frameworks, the other protection regimes can be easily compared across other European contexts.

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WHAT PLANNING FOR FACING GLOBAL CHALLENGES?

APPROACHES, POLICIES, STRATEGIES, TOOLS, ONGOING EXPERIENCES IN URBAN AREAS

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ABSTRACT

Urban areas are an amalgam of socio-ecological systems, whose interactions between environment and human activities tend to become increasingly complex due to a series of determining factors, among which climate change is overwhelming. Given its negative environmental, economic and social effects, numerous initiatives, policies, strategies, and tools are being implemented at different territorial and institutional levels, sharing common ground in seeking to maximise the health and safety, resilience, inclusion, cohesion, sustainability and prosperity of cities to the benefit of all their inhabitants and simultaneously protecting and taking care of "our common home", i.e., the Earth. Indeed, cities have a key role in combating climate change as they can not only reduce their significant contribution to global GHG emissions, but also enjoy significant local benefits in terms of local economic development and job creation, in a process of transformation from energy-consuming organisms to renewable and circular cities. Therefore, an ecological approach cannot be limited to a series of urgent and partial responses to the immediate problems of pollution, environmental decay and depletion of natural resources. A cultural revolution, a distinctive way of thinking, educational programmes, lifestyles and spirituality are needed to generate resilience to risks by proposing innovative patterns of sustainable development, an integrated approach to urban and territorial planning, infrastructure and basic services. The case studies proposed in this article suggest innovative tools, plans and projects, lessons learnt, in which spatial and socio-economic planning processes are well coordinated and cross-sectoral.

KEYWORDS

Climate Change; Nature-based Planning; New Urban Agenda and SDGs; Sustainable Urbanization

1 AN INNOVATIVE APPROACH: SUSTAINABLE URBANIZATION BY LEARNING FROM NATURE?

The growing pace of urbanization and climate change are among the main challenges that governments around the world are facing, since many others are connected to them and the future of mankind and of the entire planet depends on their solution.

According to the United Nations-Economics & Social Affairs (2018), by 2030, the world is projected to have 43 megacities with more than 10 million inhabitants, most of them in developing regions. However, some of the fastest-growing urban agglomerations are cities with fewer than 1 million inhabitants, many of them located in Asia and Africa, and close to half of the world's urban dwellers reside in much smaller settlements with fewer than 500,000 inhabitants. As the world continues to urbanize, sustainable development depends increasingly on the successful management of urban growth. Therefore, integrated policies to improve the lives of both urban and rural dwellers are needed to strengthen the linkages between urban and rural areas and build on their existing economic, social and environmental ties. In fact, urban growth is closely related to the three dimensions of sustainable development: economic, social and environmental. Well-managed urbanization can help to maximize the benefits of agglomeration while minimizing environmental degradation and other potential adverse impacts of a growing number of city dwellers, ensuring, at the same time, that its benefits are shared and that no one is left behind.

In light of these first brief considerations, the article presents the development of a broader interdisciplinary research activity focused on the possible ways of implementing the *Sustainable Development Goals* (SDGs) and the *New Urban Agenda* at a local level, with particular reference to European cities and with an integrated approach in which urban and territorial planning plays a fundamental role, from the implementation of policies to the most recent and innovative planning and design experiences.

In the *New Urban Agenda* – adopted at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III, 17-20 October 2016, Quito, EC) and endorsed by the United Nations General Assembly on 23rd of December 2016 – the United Nations (2017) recognize that "cities and human settlements face unprecedented threats from unsustainable consumption and production patterns, loss of biodiversity, pressure on ecosystems, pollution, natural and human-made disasters, and climate change and its related risks, undermining the efforts to end poverty in all its forms and dimensions and to achieve sustainable development. Given cities' demographic trends and their central role in the global economy, in the mitigation and adaptation efforts related to climate change, and in the use of resources and ecosystems, the way they are planned, financed, developed, built, governed and managed has a direct impact on sustainability and resilience well beyond urban boundaries".

The city is undoubtedly the most complex system that society has created and (Glaeser, 2011), above all in the scientific debate of the last decade, many scholars have tended to highlight its resemblance to an evolved biological organism, which lives thanks to delicate metabolic balances, feeds on matter, energy and information, metabolizes everything and produces goods, information and waste. Yet, there exists also a remarkable difference between the very long times of mutation/transformation of the evolved biological organisms (at least thousands of years) and the very rapid and continuous pace of the *organism-city*. This is the starting point to indicate viable ways to transform contemporary fossil cities into renewable cities. It is a sustainable transition where cities, minor urban settlements, rural territories and communities are the protagonists, because the local level can make the difference, implementing incisive actions in a short time and monitoring their effectiveness (Droege, 2008).

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The most recent contributions by Gunter Pauli (2015) and Geoffrey West (2018) are grafted onto this trend, and considered significant both for the innovation of the approach and the ideas they offer in an integrated and interdisciplinary perspective, also for planning and design at all scales. The former, an entrepreneur and economist, is the founder of ZERI (Zero Emission Research Initiative), an international network of scholars, scientists and economists who designs new ways of production and consumption to successfully address global challenges at the local level.

In particular, in the huge mass of waste produced by the dominant economic model, stigmatized by Pope Francis himself in the Encyclical *Laudato si'* (2015), he sees an inexhaustible source of raw materials in cascade systems for local initiatives in a network with other interlocutors of the supply chain. The concept of *Blue Economy* (the Earth is also called the *Blue Planet*) he proposes ensures that ecosystems can maintain their ability to evolve allowing everyone to benefit from the flow of creativity, adaptation and abundance that is proper to Nature. The implementation of this concept at the urban scale implies new forms of governance capable of proactively adopting the concept of resilience, understood as the capacity of socio-ecological systems to absorb a disorder and to reorganize themselves while the change is taking place (Bologna, 2014; Pultrone 2017a).

Geoffrey West, a theoretical physicist, formerly director of the Santa Fe Institute (New Mexico), offers a fascinating and, in some ways, visionary perspective on the great global challenges. He integrates themes of biology, physics, mathematics, economics, and social sciences and dedicates a specific study to the cities and to the hypothesis of a new *city science* in what he defines the current phase of *Urbanocene*. It is a new frontier because it shows the urgency of understanding the city from a more scientific, physical and quantitative point of view. West (2018, p. 269) notes that, as far as their overall infrastructure is concerned, cities have much in common with organisms and ecosystems, but differ in a distinctive and almost enigmatic aspect: they metabolize energy and resources; produce waste; process information; grow, adapt and evolve; contract diseases; and develop phenomena that could be termed tumours or uncontrolled cell proliferations. Yet, unlike all the other biological organisms destined to aging and death, they challenge time and never die, with the exception of very few cases. The initial thought, on which his reflection is based, focuses on the true function of the city, almost a magic formula that, since the birth of the urban phenomenon in antiquity, has managed to facilitate the interaction between people contributing to the creation of cultural activities, to the exchange of ideas and wealth, to the growth of innovative thinking and the encouragement of entrepreneurship and cultural activities, offering itself as an environment full of favourable opportunities for all, whose dividend is an increase in the economy of infrastructural scale.

In the era of *Urbanocene*, it is therefore essential to raise the awareness that cities are much more than their physical infrastructure. They are catalytic facilitators where action takes place, the primary driving force of economic development in which challenges must be faced in real time and where the local administration seems to work better than the ever-increasing dysfunction of the nation-state. They are extraordinarily resilient and evolving organisms, complex adaptive systems, whose sustainability can be improved integrating nature and ecosystems with the urban metabolism and socio-economic activities (Pelorosso et al., 2018). Within the business community, there is a growing interest in and awareness of the value of managing and maintaining biodiversity and ecosystem services, as a business opportunity and as an essential means to reduce economic risks by ensuring the continued supply of vital resources. The large number of international, national, regional and local policy initiatives for the conservation and sustainable use of the natural environment are evidence of policy-makers' greater awareness of the importance of nature to society (EU, 2015).

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2 CITIES AND URBAN PLANNING IN ACTION ON THE FRONTLINE

Based on what has been discussed so far, it is evident that if, on the one hand, increasing urbanization and agglomeration provide significant economies of scale for cities and regions, on the other, they can also lead to costs and externalities, such as those associated with noise, congestion and pollution, with related social and economic risks and a low level of life quality. Global challenges, such as climate change and resource depletion, affect different areas and sectors in various ways and require new and innovative responses. In this regard, the *World Bank's Eco^2 Cities: Ecological Cities as Economic Cities Initiative* – launched in 2010 as part of the World Bank's Urban and Local Government Strategy – is of particular interest since it pursues the objective to help cities in developing countries achieve a greater degree of ecological and economic sustainability (Suzuki et al., 2010). Its approach is shaped by an analysis of *best practices* in urban sustainability initiatives around the world (including Curitiba, Stockholm and Yokohama) and proposes the following four principles, which underlie the *Eco^2 framework* and have a general value, regardless of the geographical area, as they can be appropriately adapted and declined according to specific local contexts:

- principle 1, a city-based approach, which focuses on the need to enable and strengthen the leadership, capacity, and decision-making abilities of cities and their regional planning institutions. It also emphasizes the need to enhance the unique historic, cultural, and ecological resources of each city;
- principle 2, a platform for collaborative design and decision-making, which focuses on compounding the benefits of urbanization by leveraging and combining the unique capacities and resources of all stakeholders. It supports an inclusive and fair process of urban development and decision-making that involves and empowers all stakeholders;
- principle 3, a one-system approach, which strives to create a "resource regenerative and multifunctional" city. Sectors, policies, and budgets — as well as natural and man-made systems — need to work together across spatial scales and administrative jurisdictions so that the city works effectively as one system;
- principle 4, an investment framework that values sustainability and resilience, focuses on broadening the scope and extending the timeframe within which policies, plans, and investment options are assessed for costs, benefits, and risks. It supports decision-making approaches that value natural, cultural, and social capital.

Therefore, this city-based approach enables local governments to lead a development process that takes into account their specific circumstances, including their ecology, and to realize the benefits of integration by planning, designing, and managing the whole urban system in the long term.

In this wide and complex context, Urban and Territorial Planning plays a particularly significant and decisive role. It can be defined as "a decision-making process aimed at realizing economic, social, cultural and environmental goals through the development of spatial visions, strategies and plans and the application of a set of policy principles, tools, institutional and participatory mechanisms and regulatory procedures" (UN-Habitat, 2015). Furthermore, it has an inherent and fundamental economic function as a powerful instrument for reshaping the forms and functions of cities and regions in order to generate endogenous economic growth, prosperity and employment, while addressing the needs of the most vulnerable, marginalized or underserved groups.

While there are valuable lessons learnt from many cities all over the world, the *International Guidelines on Urban and Territorial Planning (Guidelines)*, published by the United Nations (2015), aim at filling a critical gap by providing a reference framework for planning that is useful across a range of scales and adaptable to

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distinct regional, national and local contexts. In order to strengthen the urban and territorial dimensions of the development agendas of national, regional and local governments, they present twelve principles that could guide decision-makers in developing or revising policies, plans and designs through an integrated planning approach (UN-Habitat, 2015).

The *Guidelines* promote key urban and territorial planning principles and recommendations that can assist all countries and cities to effectively guide urban demographic changes (growth, stagnation or decline) and improve the quality of life in existing and new urban settlements. Taking into account the principle of subsidiarity and the specific governance arrangements of each country, they can be used through the multiscale and transcalar continuum of spatial planning, at all territorial and institutional levels (supranational and transboundary, city-region and metropolitan, city and municipality up to district and neighbourhood level).

Then, urban and territorial planning is considered an essential investment in the future, a precondition for a better quality of life and successful globalization processes that respect the cultural heritage and cultural diversity. It provides a spatial framework to protect and manage the natural and built environment of cities and territories, including their biodiversity, land and natural resources, and to ensure integrated and sustainable development. Moreover, it contributes significantly to strengthening environmental and socio-economic resilience, enhancing mitigation of, and adaptation to, climate change and improving the management of natural and environmental hazards and risks (UN-Habitat, 2015).

At a European level, the Urban Agenda for the EU is part of the EU's commitment to contributing to the implementation of both the *New Urban Agenda* (Habitat III) and the *2030 Agenda for Sustainable Development*, above all Goal 11 'Make cities inclusive, safe, resilient and sustainable'.

In this regard, sustainable urban planning with nature-based solutions has positive environmental, social and economic impacts and should be integrated into all relevant political strategies and action plans. It provides opportunities for adaptation to climate change, thus increasing urban resilience to risks, such as droughts, floods and heatwaves, as well as opportunities for small-scale climate mitigation through increased carbon storage. It can also reduce pressure on peripheral natural areas. For example, wastewater can be treated closer to residential sources and provide satisfactory near-home recreation opportunities that diminish the need to travel for contact with nature (UN-Habitat, 2015). Project managers and experts working in the field of nature-based projects have identified several success factors which are relevant to such projects, from the planning, through the conception, to the implementation and maintenance phases, namely: building a strong network of actors, weaving and maintaining regular and effective public relations with specific stakeholder groups, being transparent and building trust, and being open to new ideas and approaches.

In this direction, *The Green City* initiative, established in different European countries, aims at promoting the societal and economic values of urban greenery as natural infrastructure that adds to the quality of the living climate, to urban biodiversity, and to human health and wellbeing, encouraging stakeholders to work together at an international level in the implementation of green solutions. *The Green City Foundation* is, in fact, a platform to exchange scientific initiatives, and a network to facilitate research, design, creation and maintenance of green spaces. The *Urban Nature Atlas* (https://naturvation.eu/atlas) contains almost 1000 examples of Nature-Based Solutions from across 100 European cities, each associated with the key challenges they are facing, the urban settings, sources of financing and related costs. Among these, *Pilestredet Park* is one of the largest urban ecology projects in Scandinavia that includes the redevelopment of a neglected inner-city quarter of Oslo while meeting high standards of sustainable construction. Moreover, it includes energy efficient buildings with high quality indoor environments, plenty of green areas, as well as

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an extensive stormwater runoff management system for the whole site. *Pilestredet Park* also contributes toward the development of more sustainable construction techniques and products, thanks to the strict requirements from the Environmental follow-up programme developed by the Norwegian Directorate of Public Construction and Property (Statsbygg) and Oslo Municipality.

Fig. 1 Oslo, *Pilestredet Park*. The site where the old Rikshospitalet stood is being transformed to a green area with dense housing development

Fig. 2 *Pilestredet Park*..The development process is ecologically oriented, includes environmentally friendly use of material, low energy consumption,

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In the city of Sheffield (South Yorkshire, England), the *Grey to Green Corridor* is an interesting project to transform Sheffield's Riverside Business District, which has turned 'grey' redundant road space into 'green' flower meadows and wetlands in a growing business and living area, transforming 1.3 kilometres of redundant roads into attractive new linear public spaces. This will eventually include innovative perennial flower meadows, an interlinked sustainable urban drainage system (SUDS), rain gardens, public art and high quality paved footways and street furniture. It is also a key step towards expanding the boundary of the Sheffield City Centre back to its historic origins around the River Don. The project will create an attractive setting for existing and new investment and jobs, an improvement in the city's resilience to climate change as well as an enhanced public realm and connectivity of the area with the rest of the City Centre. It also shows off new forms of partnership with the University of Sheffield Landscape School, Amey and Robert Bray Associates by sharing expertise to solve problems in an innovative way. For its quality and innovation, it received national recognition and a number of awards in 2016.

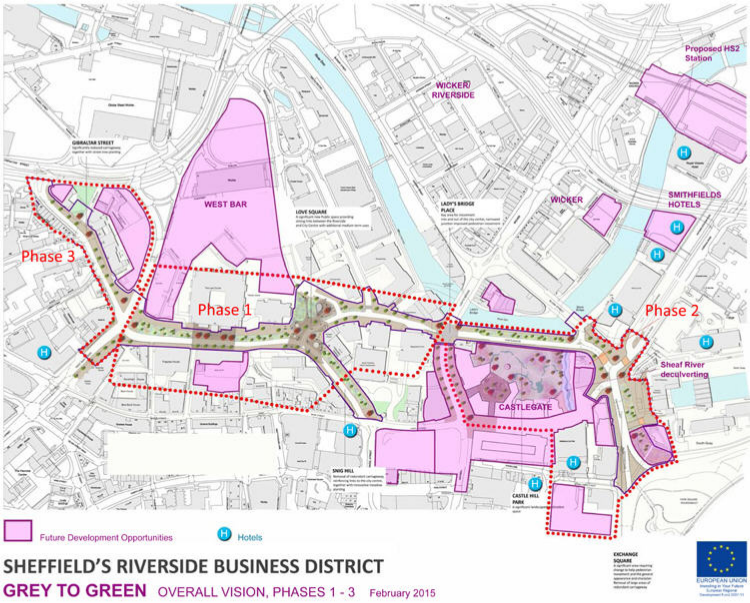

Fig. 3 The *Grey to Green* project is the UK's largest retrofit SUDS scheme

In the Netherlands, the *Room for the river project* is the expression of a new strategy that provides an alternative to the traditional solution to build ever higher dams, which, however, are not sufficient to protect cities from flooding risk. It implies making more space for water to better prevent floods by lowering the level of high water and to offer spatial quality to the area reconnecting people and rivers. Some measures of this plan are nature-based solutions. The city of Nijmegen is one of the areas where the programme took place. It was built on the south bank of the Waal river; on the opposite side of the river, the city of Lent was protected by a dike which contributed to narrowing the river to form a bottleneck prone to flooding. The project involved two main measures: relocating the dike 350 meters inland and digging an ancillary channel

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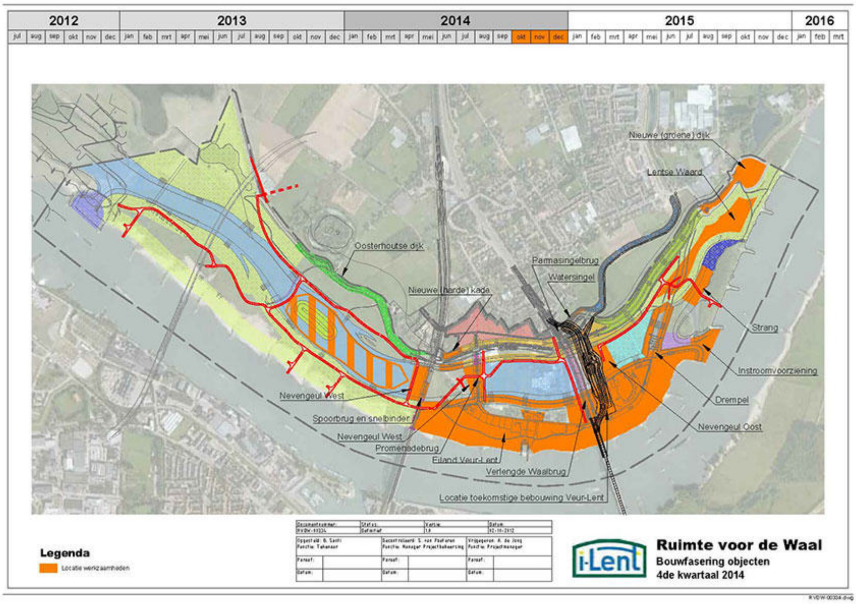
in the floodplain enabling the creation of a new island. Both actions will make more space for the river and for nature.



Figg. 4 - 5 Nijmegen. *Room for the river project* will create an island in the Waal and a unique urban river park

These developments have increasingly required indicators, standards and frameworks to guide urban sustainability policy, planning and implementation. Eco-city and SDGs indicators, standards and frameworks

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variously act as interventions in governing processes for urban sustainability and constitute a specific field of research worth of further development and analysis (Joss, 2012; Mulholland et al., 2018).

3 CONCLUSION: SHARED PATHS FOR SUSTAINABLE CITIES IN HARMONY WITH NATURE

The challenges of climate change and unprecedented urbanisation are crucial factors that involve a plethora of actors (cities, national governments, international organisations, private developers, technology firms) in conceptual, policy and practical innovation, as the key to sustainability lies in the concept of *green cities* or *eco cities* (UNEP, 2012). These can be considered as umbrella terms that covers various notions of, and approaches to, sustainable urbanism, bringing together multiple forms of sustainable development applied at different urban scales and locally contextualised, similarly to what happens for the sister terms of climate-neutral city, low-*carbon city*, *smart city*, *sustainable city*, *transition towns*, among others.

The fundamental interconnections between humanity and nature lead to the urgent need to inspire citizens and societies to reconsider how they interact with the natural world and the importance of the implementation of the *2030 Agenda* (United Nations General Assembly, 2016).

As repeatedly mentioned before, urban areas are an amalgam of socio-ecological systems, whose interactions between environment and human activities tend to become increasingly complex, mainly due to a series of determining factors, among which climate change is overwhelming. Given its negative environmental, economic and social effects, numerous initiatives, policies, strategies, tools are being implemented at different territorial and institutional levels, sharing common ground in seeking to maximise the health and safety, resilience, inclusion, cohesion, sustainability and prosperity of cities to the benefit of all their inhabitants, protecting and taking care, at the same time, of "our common home", *i.e.*, the Earth (Pope Francis, 2015). A holistic worldview, rooted in the respect for Nature and in the interdependence of humankind and the Earth, is also needed, as humanity, which is inextricably part of the community of life on Earth, cannot continue to override the laws that maintain the homeostatic balances of the Earth system. Under these conditions, the rational *homo economicus* imperatives of profit maximization, control of the market, consumption and accumulation of material goods, which give rise to a short-sighted short-term gain goal for the few, is no longer acceptable.

Indeed, cities have a key role to play in combating climate change as they can not only reduce their significant contribution to global GHG emissions, but also enjoy significant local benefits in terms of local economic development and job creation, in a process of transformation from energy-consuming organisms to renewable and circular cities, as the *Urban Agenda for the EU Circular Economy Draft Action Plan* (Partnership on Circular Economy, 2018) also states.

Considering the human roots of the global crisis, an ecological approach cannot be reduced to a series of urgent and partial responses to the immediate problems of pollution, environmental decay and depletion of natural resources. A cultural revolution, a distinctive way of thinking, policies, educational programmes, lifestyles and spirituality, which may generate resilience to risks by proposing innovative patterns of sustainable development, integrated approach to urban and territorial planning, infrastructure and basic services, are needed and cannot be delayed anymore (Pultrone 2017b, 2019). It is not enough to guarantee the quantity of urban standards and facilities in the absence of adequate attention to environmental, qualitative aspects and performances, useful to generate public value, and to the interaction with individuals who must be enabled to exercise their right to the city.

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Planning allows combining climate change mitigation, adaptation, disaster risk reduction, biodiversity conservation, and sustainable resource management (Bundesamt für Naturschutz - EcoLogic, 2014).
This is what emerges from the proposed case studies, suggesting innovative tools, plans and projects, lessons learnt, in which spatial and socio-economic planning processes are well coordinated and cross-sectoral. They document the real possibility – also recognized in the well-known document *The Future we want* (United Nations, 2012) – that, if well planned and developed, including through integrated planning and management approaches, cities can promote economically, socially and environmentally sustainable societies. Last but not least, an effective implementation and evaluation of urban and territorial planning requires continuous monitoring, periodic adjustments and sufficient capacities at all levels, as well as sustainable financial mechanisms and technologies, in order to offer effective opportunities of life in harmony with nature also in all urban areas, from the central to the most peripheral ones.

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Figg. 1-2: STATSBYGG. Pilestredet Park - a tale of sustainable urban development.

https://www.statsbygg.no/files/prosjekter/pilestredetPark/PP_brosjyreEng.pdf

Fig. 3: Grey to Green Sheffield project. http://www.greytogreen.org.uk/phase2.html

Figg. 4-5: Room for the river. http://www.ruimtevoordewaal.nl/en/room-for-the-river-waal

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ECOLOGY-BASED PLANNING

ITALIAN AND FRENCH EXPERIMENTATIONS

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ABSTRACT

This paper examines some French and Italian experimentations of green infrastructures' (GI) construction in relation to their techniques and methodologies. The construction of a multifunctional green infrastructure can lead to the generation of a number of relevant benefits able to face the increasing challenges of climate change and resilience (for example, social, ecological and environmental through the recognition of the concept of ecosystem services) and could ease the achievement of a performance-based approach. This approach, differently from the traditional prescriptive one, helps to attain a better and more flexible land-use integration.
In both countries, GI play an important role in contrasting land take and, for their adaptive and cross-scale nature, they help to generate a resilient approach to urban plans and projects. Due to their flexible and site-based nature, GI can be adapted, even if through different methodologies and approaches, both to urban and extra-urban contexts. On one hand, France, through its strong national policy on ecological networks, recognizes them as one of the major planning strategies toward a more sustainable development of territories; on the other hand, Italy has no national policy and Regions still have a hard time integrating them in already existing planning tools. In this perspective, Italian experimentations on GI construction appear to be a simple and sporadic add-on of urban and regional plans.

KEYWORDS

Green Infrastructures; Urban Planning; Landscape

1 INTRODUCTION

Emerging challenges (climate changes, loss of farmland and ecosystem services, …) that the world needs to face are obliging cities to adapt in a quick and effective way (Boyd & Juhola, 2015; Folke, 2006); planners in this context can have a central role in the definition of adequate policies and strategies. The awareness of the necessity of a new approach to planning or to the regeneration of cities has led to the conceptualization of new urban practices, more bound to ecological, environmental and landscape elements. These new urban practices have to be included in a more flexible (Davoudi, 2012), less zoning-dependent planning and it can help in speeding up the approval process.

In such a changing context, green and blue infrastructures are acquiring a wider consensus in planning practices (Meerow & Newell, 2017) as they are considered as one of the most effective strategies in land take containment, in biodiversity preservation, in the enhancement of soil ecosystems and in landscapes valorization. Their characteristics of adaptivity and cross-scaling can also help in reaching an ecology-based planning, which can overcome rigid rules of urban plans and can limit the impacts of different land-uses.

The proposed ecology-based planning takes the cue from the performance-based planning (Baker et al., 2006). The performance-based planning, as it is composed by two main components, the criteria and the methods, provides an adaptive approach to territorial systems by basing its planning choices from time to time and upon different contexts' characteristics. The ecology-based one aims at giving priority, among the criteria, to the ecological and environmental elements and, in the proposed case study, green and blue infrastructures are considered as one of the most adequate planning tools for reaching these objectives.

France and Italy are the two selected countries for the analysis; they have different approaches in dealing with green and blue infrastructures but, generally speaking, both the countries show how there is a general tendency of giving high relevance to ecological elements in planning practices.

France has been leading a relevant action in the development of a national strategy for the inclusion of green and blue infrastructures (*Trames vertes et bleues*) at all planning scales and tools (Clergeau & Blanc, 2013). Many Regions have welcomed this opportunity by drafting their own *Schéma regional de cohérence écologique* (SRCE) in which specific directives are given.

Italy does not have a national policy on green and blue infrastructures, but some Regions (for example, Piedmont and Marche) have been experiencing some attempts of methodological construction. These experimentations, although limited in terms of practicality, can bring important innovative elements in Italian planning practices.

2 ECOLOGY-BASED PLANNING

The ecology-based planning is an integral approach to planning with its main focus on ecology and environment. It mainly takes the cue from the performance-based planning which integrates different elements for the construction of a plan upon "the assumption that the impacts of land use are a function of intensity, or the physical characteristics and functions, rather than specific land uses themselves" (Baker et al., 2006). This approach has its roots and has evolved in the early 1970s above all in Anglo-Saxon planning systems (United States, Australia and New Zealand) while in Europe there is little (or even zero) evidence of its application in planning systems.

Even though significant practical results of some existing experiences are not always so evident and immediate (Frew et al., 2016), the performance-based approach to planning, as theorized in some Anglo-

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Saxon planning systems, presents different elements which can enable a much more flexible process in land uses designations.
Despite the absence of performance-based planning in European planning systems, there has been a shift, in some of them (France, the Netherlands) toward a more integrated approach to land uses, by basing planning choices not only upon zoning rules but also on their ecological and environmental values. In this perspective, a great challenge can be represented by the possibility to forecast new planning practices which are relied mainly on their ecological and environmental performance. A contribution for constructing a plan with the integration of performative criteria can arrive from the ecological approach to planning (McHarg, 1969; Steiner, 2008). Even though it is mainly bound to the American experience, some Counties have introduced performative criteria in their planning codes; they could be economic, social, environmental or a combination of them but their introduction into plans can be a mean for reaching an improved and qualitative use of soils. In addition to this, the ecological approach to planning helps to shape and to transform urban environments by taking into consideration their biophysical and socio-cultural peculiarities, according to the landscape approach to design (Mostafavi & Doherty, 2010; Waldheim, 2006).

2.1 GREEN AND BLUE INFRASTRUCTURES

In the construction of an ecology-based planning, an important role can be led by green and blue infrastructures. The international academic debate has been mainly focused on the concept of green infrastructures (Boyle et al., 2014), while the "blue element" has only been recently added with the aim of including different ecosystems. Both in American and European literature, there is not a common opinion on the definition of the concept of Green Infrastructures (GI) but many European countries decided to introduce in their national policies a project of national ecological network (such as the National Ecological Networks of the Netherlands and the French *Trames Vertes et Bleues*) and they have also been included as key elements in some European or national strategies (for example, EU Biodiversity Strategy to 2020 and the Italian Strategy for adaptation to climate change and the French National Strategy of ecological transition toward a sustainable development and the French Strategy of resilience). Some specific European regions and cities have put great attention on green and blue infrastructures (the Ruhr Region, the city of Paris in its biodiversity plan 2018-2022) by defining them as one of the major tools for generating a resilient approach to urban plans and projects. Their multifunctionality (Hansen & Pauleit, 2014; Lovell & Taylor, 2013) can indeed bring a great contribution to the preservation and enhancement of biodiversity and ecosystem services and in the valorization of the landscape. Green and blue infrastructures are closely related to each territorial context in which they are built; this characteristic enriches the possibility to reach a site-specific approach, which is one of the major elements of the performance-based planning. The experience of French *Trames Vertes et Bleues* (TVB) can be considered as one of the most representative examples in the European framework. TVB have been introduced by the French Government in 2009 and in 2010, through the approbation of the two Grenelle laws, together with the definition of a new regional plan, the *Schéma regional de cohérece écologique* (SRCE), which has to be made in collaboration with the central State. A challenging and innovative element of French TVB is that, starting from a national level, they must be included at all planning scales, even at the local and urban ones (Clergeau & Blanc, 2013). Many French Regions have approved their regional plan of ecological coherence and, among these, the Region of Rhône-

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Alpes[1] has taken advantage of some previous experiences which eased and enriched the realization of its SRCE. This plan implemented the first attempts of drafting a regional ecological network by operationalizing all the process and the methodology. Indeed, the SRCE is not only based on the simple territorial knowledge, the diagnosis and the analysis but it tries to include typical elements of the project and design approach[2]. This approach is detectable above all at an urban scale, within the experience of integrating the green and blue infrastructures strategy into the local plans (*Plan Local d'Urbanisme* or *Plan Local d'Urbanisme Intercommunal*). Nevertheless, this scale is the most challenging and difficult but two of the major cities of the Region, Lyon and Grenoble, are trying to operatively integrate them into their new intermunicipal plans. The first outcomes reveal how green and blue infrastructures can enter into urban plans in the form of punctual urban projects, through a cartographic identification and the inclusion of orientations or natural and environmental prescriptions aimed at preserving ecological continuities. The inscription of TVB in urban planning documents helps in avoiding changes of land assignment which can lead to a fragmentation of environments. On the other hand, even though Italy has not yet approved a national policy on green and blue infrastructures, it is evident how it is getting more and more important in the academic field. In the Region of Piedmont, the recent Landscape Plan (PPR) approved a scheme of the ecological and landscape network, but few Provinces have specified these directives in their coordination plans. The Metropolitan City of Turin, in its coordination plan of 2011 (PTC2), identified a strategic policy for the enhancement of green spaces and of quality of natural and built environments; one of the main principles of this strategy is the realization of a provincial ecological network. The methodology specified by the Metropolitan City has further been applied to some territorial and local contexts (municipalities of Bruino, Ivrea and Bollengo, and Chieri); the different experimentations show how, through the identification of the various components, it is possible to reach a shared scenario of ecological enhancement. These local experimentations had a great impact on supporting decision-making processes; these processes enabled the creation of an environmental performance through a specific evaluation methodology. Indeed, the proposed indicators[3] (naturality, relevance for the conservation, extroversion, fragility and irreversibility) enable to understand how much a specific territory is fragile or well preserved, in terms of ecological and environmental performance.

3 FIRST CONSIDERATIONS

Green and blue infrastructures appear to be an emerging planning tool which spans from the regional (or even national) to the urban scale. Even though the structure of green and blue infrastructures recalls to an open system of relationships which cannot be enclosed in a single municipality plan, their performative ecological character is mostly detectable at a local scale.

Indeed, at a local scale, it is easier to catch the performative elements that this planning tool could deliver in order to reach an ecology-based planning:

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[1] We refer to the Region of Rhône-Alpes before its fusion with the Region of Auvergne (Loi n. 2015-991 portant nouvelle organisation territoriale de la République) as the SRCE has been drafted separately by the two Regions.

[2] In France, there has been a great emphasis on the so-called "projet urbain" (Ingallina, 2004) which introduced innovative elements mostly related to the project approach instead to the one of planning. This concept was born as a response to the technocratic character of regional and urban planning. In this sense, the recurring reference to urban and territorial projects (instead of plans) shows a shift of vision toward a more operative way to allocate investments and resources.

[3] These experiences take the cue from the ENEA methodology, which identifies 5 different indicators for the construction of the ecological network.

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- integration of land uses with a stress on ecological and environmental elements;
- site-specific (at each scale, green and blue infrastructures are designed on the basis of territorial, landscape and environmental characteristics);
- adaptive capacity (Folke, 2006) in the shape of territorial planning choices.

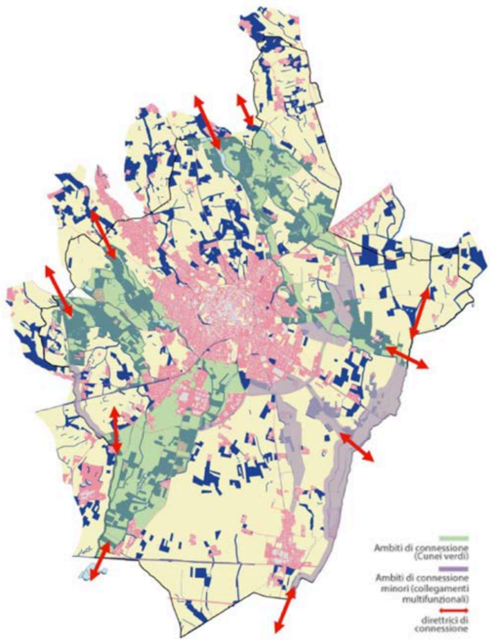

Fig. 1 Ecological network of Chieri

The two case studies, French and Italian green (and blue) infrastructures, are quite different. On the one hand, in the perspective of reaching an ecological flexible approach, the experience of French TVB shows how it is possible to transfer the different principles of green infrastructures (social, environmental, ecological, etc.) into praxis. It is also an example on how green and blue infrastructures can be a proactive tool instead of a simple add-on of urban and regional plans. This experience also demonstrate how it is possible to include such an ecological planning strategy in all the different planning scales.

Italian experimentations, on the other hand, offer a relevant methodological approach, which, starting from specific indicators, offers a deepened overview on the ecological and environmental performance of a territory. Nevertheless, these experimentations appear to be not so integrated in the planning process; a more integrated approach to ecology in planning could therefore lead to a better management of different land uses and, with the help of more flexible tools (as green and blue infrastructures could be), to a more adaptive and transformable planning process and its tools.

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THE GEOLOGICAL WORKSHOP OF GEODESIGN FOR LANDSCAPE PLANNING

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ABSTRACT

Geology has always been present in the process of transformation of the anthropic landscape. However, the role of Geology in landscape planning is still incipient and has not been the subject of an integrated policy. Linked to this and to the need of professionals related to Geology and Mining to participate actively in planning, the Geodesign technique was chosen to elaborate an alternative future plan for the Iron Quadrangle region, in Minas Gerais, Brazil, using Geology as base.

In this way, a Geodesign Workshop was held with several professionals related to Mining and obtained a territorial plan for the region. This result generated the Decision Model, which is consistent with the study area and showed that the method used is assertive for landscape and territory planning.

KEYWORDS

Geoprocessing; Geodesign; Geology; Landscape Planning; Territorial Planning

1 INTRODUCTION

The present work represents geology as a tool for territorial planning, based on geological-related issues and using the Geodesign Framework to find solutions to the conflicts in the area. The great importance of the geological processes, which can explain the forms of occupation of the territory from the beginning, influencing its evolution and the processes of transformation of the landscape, is highlighted. The decision by the area of work as the Quadrilátero Ferrífero was motivated by the fact that this region is local of the most diverse interests-social, environmental and economic. The mountains that connect from Rio de Janeiro to the Quadrilátero Ferrífero form an alignment of peaks, which served as a reference for the pioneers in the interiorization of the Brazilian territory. This geological influence was the main guide for the first Brazilians who went to Brazil to explore and also to search for precious metals. After all, these pioneers imagined that due to the alignment of this region with Potosi - Bolivia (Machado, 2009), where the Spanishs were already mining, they would be able to do the same in Brazilian lands. Being a visual guide for the explorers, the geological features and their geomorphological consequences led and influenced the beginning of the urbanization of the interior of Brazil. The beginning of the internationalization history of Brazil has embryonic connections to geology and geomorphology. This relationship can be observed in the reflection of Paraizo (2004) with Machado (2009), "a knowledge about the formative processes of our planet and its evolution in time," which served as a guide for man since the beginning of its history. The development of the geological processes together with the geomorphological processes model the terrain in a primary and secondary form, acting in a constant way. These events have long temporal spaces, practically unassimilable for human perception. Therefore, from the beginning of human presence on Earth, the terrain model is practically the same, and man himself is the greatest modifier of the same. These man-made modifications have generated the most diverse conflicts of interest, whether economic or environmental. In this way, observing this current context, it was decided to carry out the Geodesign procedure to create possibilities of alternative futures in relation to the study area. The Framework used in the area is shown as an interesting logical structure to discuss the territory. In view of the above, the proposal of this work is to discuss the potential of Geodesign to characterize the discussion of conflicts of interest in landscape management, using the case study carried out in the Quadrilátero Ferrífero area (Fig. 2). Recent works cite the transformation in the landscape directly related to industrialization, which, in the case of the study area, is mining (Sonter, 2013; Sonter, 2014). Just as the occupation of the territory is directly related to the economic use, because it was the presence of mineral deposits that conditioned the colonization of the region by the Portuguese at the end of the XVII century (Roja, 2014; Sanches, 2012). In parallel with the economic interest, environmental interest also happens, which generates spatial conflicts, as there is overlap and juxtaposition of interests between the parties that work in this space. It is also observed that the area is urban growth, since it corresponds to the south vector of the Metropolitan Region of Belo Horizonte (Tonucci Filho, 2012). In the study area, there are expressive compositions of the three main sectors mentioned above (mineral sector, urban and environmental planning) (Roja, 2014; Souza, 2007). As a result, there are environmental and territorial conflicts in the Quadrilátero Ferrífero, related to the different interests of the use of the territory and its evolution linked to hegemonic agents (Silva, 2007; Souza, 2007). The Quadrilátero Ferrífero was chosen as a study area due to its importance in the context of the State of Minas Gerais. This region brings together a great variety and richness of natural elements, in which the economy of the State of Minas Gerais is inserted, with mining as an economic symbol. The region is located in the center-southeast portion of the state and occupies an area of approximately 7,000 sq km. The taxonomic origin of the region was named by

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Gonzaga de Campos (Dorr, 1969; Ruchkys, 2007; Scliar, 1992), due to the iron ore deposits found there, located at extreme locations in the municipalities of Itabira, Mariana, Congonhas and Itaúna, which are geographically arranged quadrangular in the territory in question (Fig. 2). The region has many mineral resources, being one of the two main mining provinces of the country. In addition, there are a wide range of other relevant factors such as the local landscape, type of vegetation that occurs only in this area, source of important rivers in the formation of the regional and national water network (Silva, 2007). It is also observed a significant quantity of patrimonial assets, due to their occupation by the colonizers in the phase of historical importance of formation of the Brazilian society.

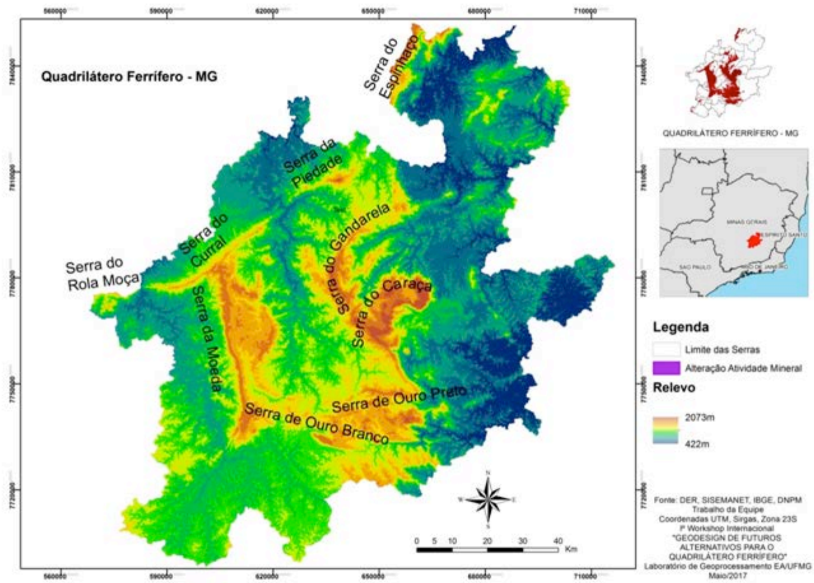

Fig. 1 Quadrilátero Ferrífero area. Source: authored by the author

Understanding the values of the Quadrilátero Ferrífero is much more difficult than imagined, since it makes the understanding of urban occupation and expansion conflicting with landscape conservation and mining activity. Because it is an area delimited by saws and of great environmental, mineral and geological representativeness, and being located the capital of the state to the north of the Serra do Curral, the mountains act as the main limiting factors for an easy integration of the region (Conti, 2009). Being surrounded, from north to south and west to east (Fig. 3), by the mountain range of Serra Azul, Serra do Rola Moça, Serra do Curral and Serra da Piedade (north flank); Serra da Moeda (west flank); Serra de Ouro Branco and Serra de Ouro Preto (South flank); Serra do Caraça and Serra do Gandarela (east flank) (Dorr, 1969).

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Fig. 2 Location of the Quadrilátero Ferrífero (Source: Ruchkys, 2009)

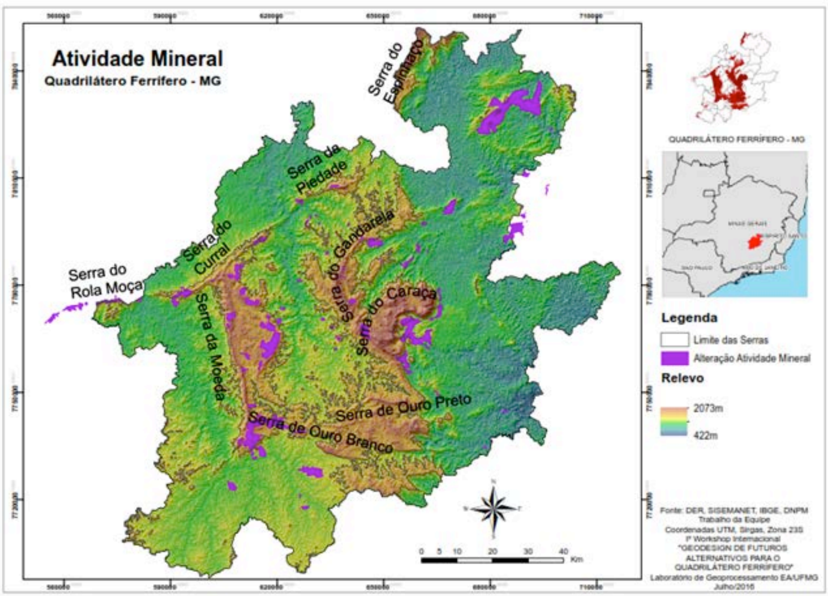

Fig. 3 Mountain range around the Quadrilátero Ferrífero. Source: authored by the author

2 OBJECTIVE

What is wanted is a review of the geologist's position regarding the possibility of experience a shared project and make it a legacy to the profession. That he may participate in projects in which there is co-creation and sharing of decision making, being part of the collective decisions of the society, in which, usually, this professional is left and left out. And let the Geologist listen and be heard by other professionals, in focus geological or not, so that there may be a greater interaction of work and that there is compatibility among

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related areas. Thus there is a need to understand the role of this professional as an important part of planning and open possibilities for the geologist to act in these processes. To the point where compatibility is the basis of the methodological process used in this work, and in turn is the methodological basis of Geodesign, developed by Carl Steinitz in 2012.

3 GEODESIGN FRAMEWORK

Carl Steinitz (2012) defined Geodesign as "a tool based on a set of questions and methods necessary to solve large, complicated and significant design problems at various geographical scales, ranging from a neighborhood to a city, landscape or basin hydrographic ". Geodesign can also be defined as an integrated process, undermined by the assessment of environmental sustainability, aimed at solving complex problems related to environmental and territorial issues and directly linked to social and economic issues (Dangermond, 2010). The practice of this technique requires the collaboration of several professions (Fig. 4), among them, environmental design, geographic sciences, information technology and local people (Steinitz, 2012).

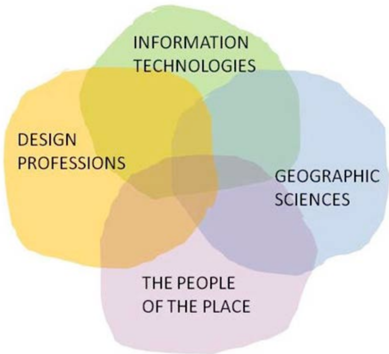

Fig. 4 Geodesign Framework. Source: STEINITZ, 2012

Once the technical team is formed, the initial questioning stage begins, present in the first iteration (Fig. 5), which are composed of six questions:

- How should the study area be described?
- How does the study area operate?
- Is the current study area working well?
- How might the study area be altered?
- What differences might the changes cause?
- How should the study area be changed?

After this initial stage, the preparation, implementation and conduction of the six models proposed by Carl Steinitz (2012) will begin: Representation Model, Process Model, Evaluation Model, Change Model, Impact Model and Decision Model.

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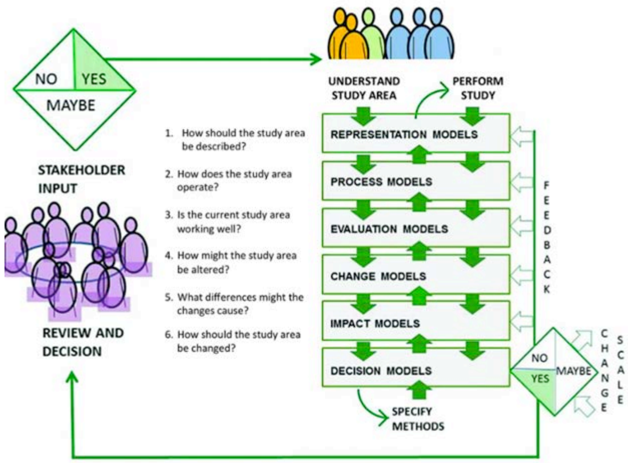

Fig. 5 Geodesign Framework. Source: STEINITZ, 2012

4 CONCLUSION. THE HEOLOGIST AS PART OF THE LANDASCAPE PLANNING AND COLLABORATIVE PROJECTS

Nowadays, it is widely held that decisions must be taken by multidisciplinary teams and with the involvement of all sectors of the society, a guideline present in the Constitution of the Federative Republic of 1988, reaffirmed for the urban scale in the 2001 Statute of the City. occurs at a certain level within the Government, but the geologist's are not so embedded in these processes of collective discussion.

Geology is the basis of society, since virtually everything that is built on the continents and these are supported by the rocks, being such science the pillar for the sustentation of the anthropic activities. Consequently, the geologist has space to participate in collective decision-making, being the professional who understands the endogenous dynamics of the planet.

This profession thus encompasses much more than is done by (mining and geological mapping are the main attributions of the professional who is in the market). Specifically on the area of study of the present study, it is necessary to understand how important the geologist is to the studies of the region, and that he should be one of the main planning agents for the Quadrilátero Ferrífero, since virtually all aspects of this territory have strong links with the issues of the geological features.

Geology strongly influences the landscape and its values to be conservation, environmental and economic riches, the expansions of anthropization by mineral explorations and by expressive urban growth and the essence of genius loci of the place, which is the mining landscape.

Therefore, this work has two main factors: research on the potential of the Geodesign Framework and the discussion on the potential of insertion of the geologist in the collective decision-making about future of a landscape.

It is important to state that, (i) by means of the Geodesign for planning, if you have obtained a final product consistent with the realistic and enforceable; and (ii) the representativeness of the geologist for the the preparation of co-creation projects and for decision-making should be respected and taken into account.

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Finally, it is advisable to record the new contemporary values in landscape planning and management processes, viewed as collective goods, which consider the shared decision. In this sense, the Geodesign method (draw "with" and "for" the territory - geo + design) is a positive exponent. There is space for all social actors and all professions linked to change and modification of the landscape in this process. Therefore, the discussions here presented may be continued by professionals involved in territorial transformation and by the Public Power, aiming at solving present in territories with conflicts of interest.

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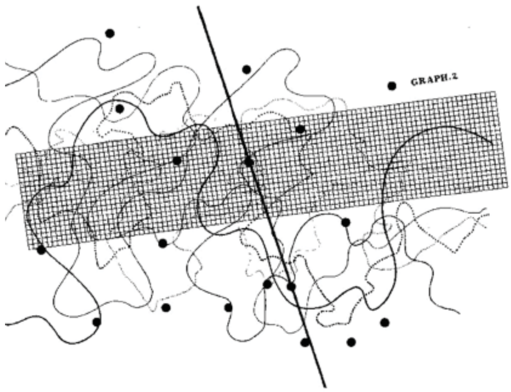

A HYBRID DECISION-MAKING PROCESS FOR WASTESCAPES REMEDIATION

GEODESIGN, LCA, URBAN LIVING LAB INTERPLAY

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ABSTRACT

Horizon2020 REPAiR project, REsource Management in Peri-urban AReas. Going beyond Urban Metabolism (http://h2020repair.eu/), investigates the flows of material looking for those dysfunctions of urban metabolism that determine landscapes of waste, so-called "wastescapes". According to the principles of Circular Economy (CE), wastescape can be considered an innovative resource for the regeneration of territories in crisis, and allow a change of paradigm able to determine multiple and different environmental, economic, social and cultural implications. The methodological approach aims at making operational the concept of Urban Metabolism, according to the CE principles, deepening the dynamics between energy flows, waste, information and people and identifying ecological and innovative solutions deriving from a win-win-win approach, considering the environmental, social and economic impacts of the transformations and the benefits deriving from the intrinsic relationships inherent in metabolic systems. The key challenge is to integrate models and methods to enable stakeholders to use the platform of GeoDesign Decision Support Environment (GDSE) for the interaction between the Life Cycle Assessment (LCA) and Peri-Urban Living Labs (PULLs) in order to develop reliable alternatives for spatial sustainable development strategies able to enhancing waste and resource management. A hybrid decision-making process consists of that tree interactive processes, where results from PULLs and LCA converge in GDSE in a reiterative methodology to enabling decision-makers to assess their decision alternatives.

KEYWORDS

Wastescape remediation; Urban Metabolism; Hybrid Decision-making Process; LCA; Living Labs; GeoDesign

1 INTRODUCTION

Waste management is an emergency in the contemporary world because waste production continues to grow up year by year. The World Bank's Urban Development Department has estimated that the municipal solid waste from the current 1.3 billion tons per year will grow to 2.2 billion tons per year by 2025.

Inefficient waste management and ineffective planning policies have gradually generated degradation of landscapes in particular in peri-urban areas with negative consequences on people health, resources loss and social conflicts. At the same time, the current linear economic model has revealed all its dysfunctions, producing loss of resources, disasters and crisis in environment, economic and social contexts.

The European Union has progressively increased systems of programmes and measures to promote the Circular Economy and obtain benefits for both the environment and the economy starting also from the wastes issues. The perspective of European Union is consistent with the United Nations that in 2015 adopted the 2030 Agenda for Sustainable Development, to end poverty, protect the planet and ensure prosperity, identifying 17 goals, with the aims to make cities and human settlements inclusive, safe, resilient and sustainable and ensure sustainable consumption and production patterns (United Nations, 2015).

Starting from the European policies and regulations on waste management (2008/9/EC), and taking into account the recent ISPRA 2017 and 2018 reports on urban waste and special waste, it is possible to identify the specifics of waste landscapes, also in relation to the flows of materials, energy and type of waste, and define if, when and where they can become a productive resource for the local Urban Metabolism (UM).

In Italy, waste management has globally improved over the last decade, but the legacy to be faced remains a serious problem. Improving the whole process of waste management needs a paradigm shift toward Life Cycle Thinking (LCT) to consider waste and wasted landscapes as a resource. In this kind of process Knowledge Management (KM) plays a central aspect, both in the communication of results and in the creation of an enabling context. The work to design solutions to face local regeneration and improve waste management requires communities and contexts prepared to follow and develop new paths. In the field of Knowledge Management (KM) is emerged that creating an enabling context is the first fundamental step to encourages knowledge sharing, creation and use (Choo & Alvarenga Neto, 2010).

The paper describes the hybrid decision-making process implemented in the Horizon 2020 REPAiR project, that integrates different approaches to enable wastescapes regeneration in different European case studies, analyzing the central role of the GeoDesign approach.

2 FROM WASTE TO WASTESCAPES IN REPAIR PROJECT

The waste emergency in Campania, ended in 2009, has left the so-called "Land of Fires" region, a legacy marked by land to be reclaimed, a lack of recycling facilities and extensive landfills authorized and not, whose proximity to residential areas has provided further aggravation of environmental issues of peri-urban districts with consequent irreversible damage to the health of the inhabitants. In this context, the Horizon2020 REPAiR project, REsource Management in Periurban AReas. Going beyond Urban Metabolism (http://h2020repair.eu/), consisting of a consortium of universities, public and private bodies, investigates the flows of material looking for those dysfunctions of Urban Metabolism that determine landscapes of waste, wastescapes, in order to design suitable eco-innovative solutions.

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Land of Fires, Italian case study, is one the most complex areas of Campania region. Waste management and planning policies are the results of decades of political inefficiency and of continuous illegal actions, that underline inner difficulties of administrations in waste management, cooperation and social obstacles.
REPAiR project involves 18 partners from six countries: Italy, Netherlands, Germany, Belgium, Hungary and Poland. The Italian partner is the Department of Architecture (DiARC) of University of Naples "Federico II" in cooperation with the Campania Regional Authority (CRA). The ambition of the project is to elaborate eco-innovative solutions, investigating simultaneously wastescape and waste flows, by the support of a hybrid methodology to achieve this goal, able to combine soft and hard approaches and tools.
A key issue is related to the concept of Urban Metabolism (UM), starting from the interpretation of Kennedy et al. (2007) as the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste. According to Broto et al. (2012) UM links material flows with ecological processes and social change by the understanding of flows and circularity. Ultimately, UM describes the continuous flows of resources (as water, energy, food, materials, waste, information, people) into, out of, and within metropolitan areas. Considering an urban area as the result of interacting complex systems means analysing the city as an ecosystem, where improving technical and socioeconomics processes mean to reduce waste and loss of resources flows.
According to the above perspective, cities dysfunctions are investigated through measurable impact in the wastescapes, patches of damaged lands in peri-urban areas, where urban and rural environments intersect. Wastescapes have been defined as "patches of landscape related to waste cycles both by functional relations and because they are 'wasted-lands': anomalous areas inconsistent with the peri-urban metabolism that become neglected spaces" (Russo et al., 2017). The Italian case study in REPAiR project, Naples Focus area, is composed of 11 selected municipalities (Acerra, Afragola, Caivano, Cardito, Casoria, Casalnuovo di Napoli, Cercola, Crispano, Frattamaggiore, Napoli, Volla), all composing the Land of Fire: an area that has been affected by waste emergency since 2009 and whose legacy is its biggest problem to address (Fig. 1).

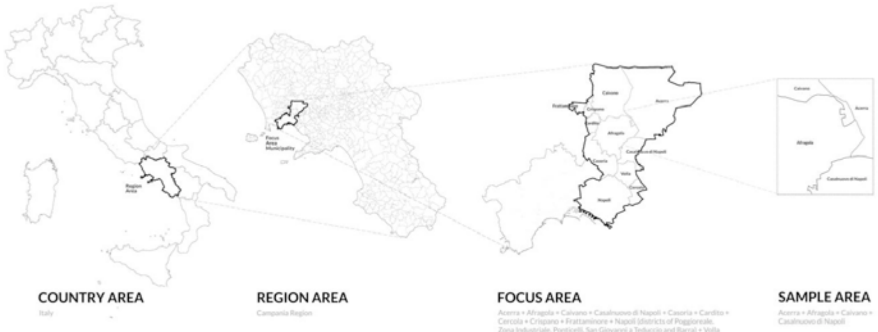

Fig.1 Project REPAiR – Italian Case Study – Naples Focus Area (source: REPAiR D3.3, 2018)

In a Circular Economy (CE) perspective, wastescapes can be considered a resource. Six categories of wastescapes have been selected as innovative resources to be reintegrated in the metabolic dynamics, to improve quality of the peri-urban areas. Some of these categories could be found at the scale of the entire focus area; other categories could be mapped instead only at a local scale, thanks to the interactions with local stakeholders and communities. Some categories are likely to overlap each other in the mapping process. The main wastescapes categories are identified as: Degraded land (W1), Degraded water and

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connected areas (W2), Declining fields (W3), Settlements and buildings in crisis (W4), "Dross" of facilities and infrastructures (W5) and Operational Infrastructures of Waste (W6) (Geldermans et al., 2018).
The challenge to design suitable solutions for these kinds of landscapes, considering material flows and local communities knowledge and involvement, has been pursued structuring a methodology that systematize three different approaches in one hybrid framework, considering the following main objectives: To provide decision-makers with comparative assessments of different integrated spatial resource management strategies by combining forecasting methods, strategy conceptualizations and an integrated assessment of economic, environmental and social sustainability in a collaborative decision support environment; to develop an understanding of the characteristics, mechanisms and dynamics of European resource management systems by analyzing the relations between waste flows, environmental and spatial quality, allocation and governance in six peri-urban areas using life cycle thinking; to better interpret the link between metabolic flows and urban processes, by extending the assessment of urban metabolism to include urban driver concepts and urban patterns, as well as environmental and spatial quality, and co-benefits; to improve the knowledge and reliability of waste related data by reversed material flow accounting; to implement living labs in peri-urban areas (Peri-Urban Living Lab - PULL) in order to develop, test, implement and assess place-specific eco-innovative solutions for resource management to improve environmental and spatial quality and quality of life; to understand decision-making structures and processes in the case study areas with regard to interests and priorities of different stakeholders in order to add transparency to the decision making process; to disseminate and ensure the further uptake of the project's insights on aspects of resource management and GDSE development by including local and regional planning authorities, NGOs, public and private waste management companies, and future urban planners in the project. Moreover, open dissemination of insights, tools and technologies is provided across Europe, establishing the foundation for knowledge-based consultancy services that support local implementation of policies and spatial investments aimed at developing a CE.

3 THE METHODOLOGICAL FRAMEWORK

Research methodology of REPAiR project follows three iterations framework connected each other, according to Steinitz (2012) and Campagna (2014) methods, where GeoDesign Spatial Environment (GDSE) can be considered as the digital enabling context, where research results converge in reiterative phases of co-design and co-evaluation. Enabling conditions are the premise for the identification of an enabling context (Nonaka et al., 2000) and can be related to:

- social/behavioural: social relationships and interactions based on norms and values such as trust, care, empathy, attentive enquiry and tolerance;
- cognitive/epistemic: the need for both epistemic diversity and common knowledge or shared epistemic practices and commitments;
- information systems/management: the use of information systems and information management processes to support knowledge activities;
- strategy/structure: the need for the organisation and its management to provide direction and structure.

Therefore, in REPAiR projects, enabling contexts can be defined considering the following parameters (Geldermans et al., 2018):

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- they may be wastescapes: depending on the factor of use, underused areas might more easily accommodate new eco-innovative processes;
- they may be public or private areas. In fact, abandoned public areas could be re-used more easily as compared to similar private areas. Moreover, experiments in the public areas could be a catalyst for the private areas, where the owner could follow the example of the public initiatives;
- they may be easily accessible. The importance of the accessibility is crucial for the implementation of the eco-innovative solutions; in fact, the possibility to access the area via public transportation, by bike or on foot can determine the choice of one solution over another as well as its success or failure;
- local stakeholders may or may not be interested in the transformation of the area. This is a quite clear parameter that guides the selection of a specific location for the implementation of a solution;
- they may be crucial in relation to the waste-specific geography, as being crossed by relevant flows, sources/delivery points of the waste-flows for which the case study providing deeper knowledge.

In the above conditions, it could be relevant to activate a hybrid decision-making process in order to systematize the work of several expert teams from industrial ecology, economy, sustainability analysis, spatial planning, environmental policies and to build the suitable context where it is possible to generate eco-innovative solutions. The decision-making process is structured by interactive parts of the three main frameworks where the main steps are developed in each framework context as in the following scheme (Fig. 2): A. wastescape/waste cycle selection; B. integrated spatial analysis, material flow analysis and social analysis; C. end-of-life scenarios; D. eco-innovative implementation; E. local/global impact assessment; F. suitable scenario selection.

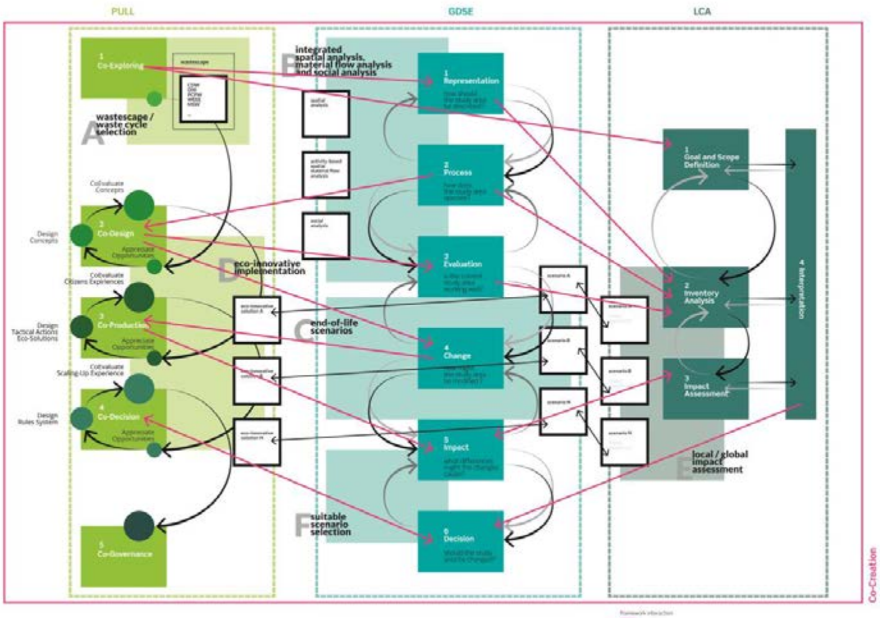

Fig. 2 The methodological framework where PULL, GDSE and LCA interact (source: Geldermans et al., 2017)

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The three main frameworks identify three different approaches:

- GeoDesign Decision Support Environment (GDSE) is the central approach, and the platform where hard and soft data converge;
- Life Cycle Assessment (LCA) is the approach used to assess the different impacts;
- Peri-Urban Living Lab (PULL) is the approach used to interact with the real-life context (De Bonis et al., 2014), where knowledge is shared and where co-design process becomes effective using GDSE platform.

REPAiR project applies a GDSE approach aims to reveal both local and space-specific challenges of waste and resource management as well as integrated and place-based eco-innovative solutions for these challenges. In the terminology of the REPAiR project, a "solution" is a technical, organisational or juridical approach to solve one specific material and waste management challenge. Combinations of solutions are called "strategies". Thus, a GDSE is a tool to develop and comparatively assess alternative strategies in the field of material and waste management (Arciniegas et al., 2016).

One of the aims of the REPAiR project is to develop, test and apply the GDSE, conceived as an open source product designed for a use within workshop session of the Peri-Urban Living Labs (PULLs), where small groups of participants cooperatively develop strategies consistent with CE model and with a special focus on waste and resource management.

REPAiR adapts Steinitz's (2012) GeoDesign framework, comprising six questions that are asked at, at least three points in a GeoDesign project to understand the study area, to specify the methods and to perform the study: 1. How should the study area be described? 2. How does the study area operate? 3. Is the current study area working well? 4. How might the study area be altered? 5. What differences might the changes cause? 6. How should the study area be changed?

As much as it is helpful to the REPAiR, Steinitz's approach was not yet extensively applied to research questions in the field of waste and recycling. Waste and recycling are closely linked to production chains, and the degree to which production chains are meeting the requirements of the "cradle to cradle" vision can be measured using Life Cycle Assessment (LCA). In REPAiR, LCA is therefore added as an essential component to Steinitz's approach, for analyzing the impacts of products along with all steps of its production chain and therefore as part of the co-evaluation of eco-innovative strategies aiming to use waste as a resource. Linking LCA to Steinitz approach includes some methodological challenges, with specific attention to the spatial dimension, not included in the current state-of-the-art of the LCA methodology. Therefore the GSDE aims to find a way of combining GeoDesign and LCA by using different levels of spatial differentiation inside and outside to specific, mostly peri-urban, focus areas. At the same time, GSDE interacts with PULL phases and is the core element of communication and co-designing with the stakeholders involved in the different PULLs in order to transparently develop, access and discuss requirements and alternative options for eco-innovative solutions. The defined approach follows up on the work of Arciniegas and Janssen (2012) related to collaborative GIS-based tools and their integration in workshop settings. At the end of the REPAiR project, the GDSE will be made available as an open source tool in order to facilitate its application in other research and policy-making contexts. Once the GDSE will be published in 2019, all the materials will be available on REPAiR website.

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4 CONCLUSIONS

"Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction" is the Priority 4 of Sendai Framework for Disaster Risk Reduction. It suggests to "adopt public policies and actions that support the role of public service workers to establish or strengthen coordination and funding mechanisms and procedures for relief assistance and plan and prepare for post-disaster recovery and reconstruction", among others. Wastescape is frequently man-made high-risk landscapes. Natural disaster is louder and more striking than man-made ones, but these produces silent effects much more compound "to repair". REPAiR project is testing an hybrid decision-making process, that take place in GeoDesign environment, regards this complexity enabling to interplay expert knowledge and local communities, crossing methods, approaches and tools, because just collaborative processes can build back better damaged landscapes, and communities active awareness is the most important component for long-term sustainable transformations.

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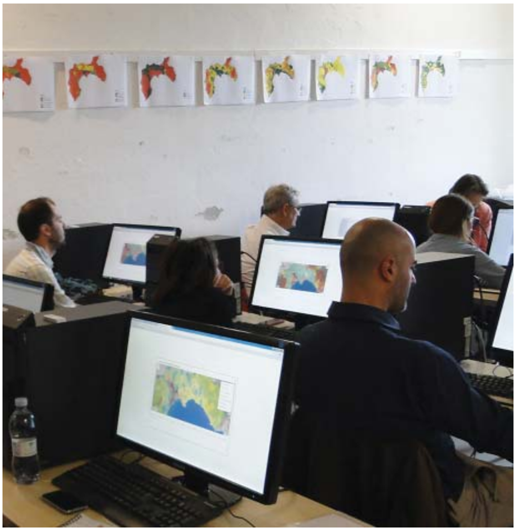

TOWARDS A NOVEL APPROACH TO GEODESIGN ANALYTICS

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ABSTRACT

The adoption of sustainability principles in current European regulatory framework which affect spatial planning and environmental protection, such as Directive 2001/42/C, introduced the need for collaboration and participation in spatial planning practices aiming at achieving more evidence-based, transparent and democratic decision making. However, the involvement of a wide range of actors, along with traditional collaborative and participatory methods, makes it often difficult to grasp the dynamics which drive the process towards the final decision. Emerging design methodologies and increased recourse to advanced information technologies promise unprecedented opportunities not only for applying a system approach and coordinating involved actors, but also for tracking the evolution of the design alternatives toward the final plan. In this context, this paper explores the potential offered by the collaborative Planning Support System Geodesignhub to ease and record the process workflow of geodesign studies. The paper describes underlying theories, research questions formulation and the first results of the analysis of empirical data on the Cagliari Geodesign case study. The set of variables and relations identified in this research endeavor represents the first effort towards the development of an operation framework for geodesign process analysis, which may potentially contribute to clarify the relationships between the knowledge base and the actors in the planning process. The aim is to earning a deeper understanding of the process dynamics for more informed, transparent, and democratic planning, design and decision-making.

KEYWORDS

Geodesign; Process Analytics; Planning Support Systems; Spatial Planning and Design; Collaborative Decision Process

1 INTRODUCTION

Since the early 1990s, the global debate on sustainable development has highlighted the importance of strengthening the decision-making process to ensure, on the one hand, the progressive integration of environmental concerns in spatial planning at different scales, and on the other hand, a wider public participation in the process (UN-WCED, 1987; UNGA, 1992a). The full implementation of Agenda 21 and the commitment to the Rio Declaration principles (UNGA, 1992b) were strongly reaffirmed at the United Nations Summit 2015 by adopting the resolution “Transforming our world: the 2030 Agenda for Sustainable Development” (UNGA, 2015). The core of the outcome document consists of 17 goals that are intended to guide global efforts towards a sustainable future over the next decade. Goals 11 and 16, in particular, acknowledge the need for participatory and integrate human settlement planning, and for responsive and inclusive decision-making at all administrative level. In terms of policy instruments, in Europe the Directive on Strategic Environmental Assessment (SEA - 2001/42/EC) provided renewed impetus for Member States to incorporate environmental considerations into plans and programs, while ensuring transparent and participatory decision-making processes. SEA procedure can, therefore, contribute to an informed and democratic environmental governance facilitating more sustainable forms of development. Despite difficulties on translating guidances into practice, public participation is acknowledged as a defining feature of SEA processes and as an essential element to achieve 2030’s sustainability objectives. Operationally, typical spatial planning situations featuring public participation may involve a variable number of actors in many different type of evaluation and decision phases, and have a mix of unstructured and structured activities. The approaches to handling these key aspects had varied over time with the evolution of different planning theories and approaches (Khakee, 1998, 1999) affecting the overall planning process, in particular the definition of a set of design objectives, the construction of the territorial knowledge and how it influences the creation of design alternatives. Among the eight paradigms or theoretical models synthesized by Khakee (1998), in the rational-comprehensive planning, for example, the decision-making process should be well defined in all its phases, the objectives should be chosen at the political level and the planners should formulate alternative proposals according to an expert approach. Conversely, according to the most recent paradigm of communicative planning, technicians no longer develop models applying purely the scientific method, but their role is also to highlights priorities and requirements of the various social groups involved. In the advocacy, transactive and communicative planning, the local community in its various social components participates, albeit with different levels of "social interaction" (Arnstein, 1969; Forester, 1999; Friedmann, 1993), to the more or less structured phases of the process. Nevertheless, despite recognizing the growing importance of participation in spatial planning, citizens involvement in current SEA practice is still relatively poor and with limited influence on actual decision-making (Chaker et al., 2006; Gauthier et al., 2011; Rega & Baldizzone, 2015). Even in those cases where effective public engagement takes place, there is a lack of information and documentation with respect to timing, means and methods. More generally, several authors have highlighted a series of issues in the application of the SEA procedures in the Member States of the European Union, both at the local and the regional level (Arcidiacono, 2012; COWI, 2009; Fischer, 2010; Parker, 2007). Specifically, the objectives of transparency most often cannot be sufficiently achieved: it is often difficult to identify the responsibilities within the decision-making processes for what generate negative impacts on the affected communities; the desired relationship between the identification of environmental issues and the development of design alternatives is not always straightforward. The process for moving expert and experiential knowledge to action in spatial planning is complex and often

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characterized by informal, undefined and/or not well documented activities. Hence the dynamics of the stakeholders' participation and of the entire design process are often poorly understood, limiting greatly transparency and responsibility. Since the inception SEA, scholars and practitioners have devoted much attention to the development of techniques to facilitate its implementation. Among them Campagna and Di Cesare (2016) pointed to the potential offered by geodesign – a renewed approach for complex design problem solving – to address many of the issues encountered in SEA application. Contemporary debate on spatial planning showed an increased interest in geodesign concepts and methodology. It is in this context that Steinitz (2012) proposed his geodesign framework (GDF) as an interrelated set of models to implement forward-thinking, interdisciplinary, system-thinking design processes. Geodesign current growing interest among academic and professionals is closely related to recent advances in geospatial information and communication technologies. For decades, after the early conceptualization of Britton Harris (1989), research on Planning Support System (PSS) aimed at designing reliable integrated information system to help planners implementing digital workflows, however they had somewhat limited diffusion due to several factors including, to recall few, the limited digital literacy by professionals, the fear of blackbox effect, or, their somewhat narrow scope. Indeed, most of them focused in supporting very specific tasks of the planning and design process, at the cost of substantial resources required. More recently, the Geodesignhub PSS contributed to address the latter issue for it enabled the implementation of workflows which cover the span of the whole design process from knowledge building (in GIS) to design and impact assessment (with the system itself). In addition, Geodesignhub is designed to support collaboration and negotiation, and can record log-data about the whole process with regards to design and to the actions of the involved actors, which contribute to generate a final solution. The opportunity of making value of the geodesign (i.e. planning and design) digital log-data is unprecedented, and it worth to be investigated further as it may contribute to offer a better understanding of the process unfolding, and of its results. On the base of the above assumptions, and with the aim of making the value of the design process log-data in the following paragraph the Enhanced Adaptive Structural Theory (EAST2) by Jankowski and Nyerges (2001) was used as theoretical framework to guide the first steps of a geodesign process analysis. The log-data recorded by the by the collaborative PSS Geodesignhub during a geodesign case study were analyzed with a view to explore the dynamics of participation and interaction among stakeholders involved in a computer-mediated collaborative planning and design process. Early results are shown and discussed in the last section as a promising contribution towards a novel geodesign analytics approach.

2 METHODOLOGY

The use of the structured decision-making workflow of geodesign allows to effectively organize the key aspects of the process: the contribution of the local community within the different phases, and the use of appropriate PSS to support the implementation of specific steps. Public participation can play an important role in the overall process or may occur only at some phases previously defined, e.g. citizens are involved to integrate local and expert knowledge of the territory thus informing the design of technicians; members of the community are invited to propose change alternatives in a collaborative decision-making process. The latter case is likely to be supported by the web-based tool Geodesignhub (https://www.geodesignhub.com/) since it allows stakeholders to effectively contribute in the last three models (Steinitz, 2012) of a geodesign process. In a planning and design study with Geodesignhub - usually carried on with a two-day workshop – an ideal number of 30 participants among representatives of local community, each with their own access to the system web-based interface, can draw individual design proposals called *diagrams* to improve the

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existing conditions of up to 10 relevant territorial systems. An evaluation map for each system is previously built on the basis of expert and/or experiential knowledge. The participants divided into stakeholder groups can easily select *diagrams* to develop a composite design alternatives (*syntheses*) in line with their specific change priorities. Early design proposals are then assessed against their impacts over the existing conditions to frame refined *syntheses* before starting the negotiation phase. Geodesignhub supports stakeholder coalitions in creating negotiated *syntheses* towards achieving a consensus thanks to the availability of specific tools for the purpose.

In Geodesignhub the entire process, as briefly described above, is recorded in the database structure and all the created *diagrams* are available for download. Geodesignhub stores the spatial and temporal information associated with a *diagram*, but also thematic attributes (e.g. authorship, relevant territorial system, authors' preferences), and multimedia contents, if available. Furthermore, the design evolution can be traced back by downloading group/coalition *syntheses* created throughout the entire process, which contains information on the selected *diagrams*, the change team who created it and the exact timing.

In a post-workshop phase, thanks to the process log-data preparation and organization in a geodatabase (Fig. 1), it is possible to explore the various analytical dimensions using spatial analysis, geoprocessing tools and statistical software. However, in order to make value out of the data, the analyses required a novel ad-hoc approach for planning process data have a peculiar structure which differs from tradition spatial information (i.e. location and features thematic attributes) for it integrates design but also social-behavioural information.

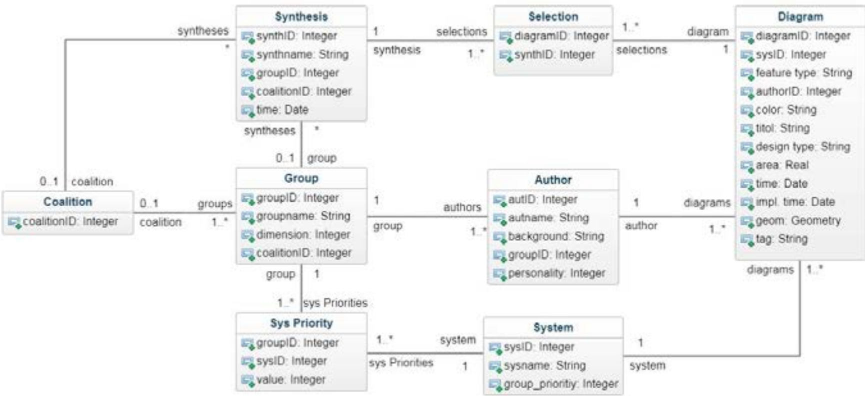

Fig. 1 The relational model of the geodesign process log-data geodatabase

This study, which is still in its early stages, ultimately aims at identifying and understanding design dynamics within a geodesign project, whereas a wider set of analytical dimensions is nowadays made available through new digital technologies. A deductive-inductive approach is adopted which drew upon both process and design theories to formulate research questions, and bottom-up exploratory empirical log-data analyses to verify potential relations between dimensions.

Various theories can be used to frame the concepts and relationships that motivate questions about planning process dynamics. Among potentially useful theoretical frameworks, EAST2, in its latest version, as proposed by Jankowski and Nyerges in 2001 can be of substantial support. EAST2 is based on eight analytical perspectives (*constructs*) subdivided in 25 *aspects*, which outline significant issues for characterizing

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collaborative decision making. In addition, seven *premises* describe the relations between the eight perspectives. This approach can be used both i) to develop a comprehensive description of each phase of the decision strategy helping to select/develop appropriate support tools and methods, or ii) to understand already developed empirical case studies practically, and researching the social and design dynamics of the decision process. In the former case, the proposed approach is relevant to the concept of Metaplanning (Campagna, 2012, 2016), defined as the planning and scheduling of the operational flow of activities, by actors, with methods and tools necessary for implementing the decision-making process. Campagna argues that a preliminary design effort can help unpacking the complexity of spatial planning process situations, avoiding imprecisely formulated activities and promoting the integration of customized supporting technologies suitable for each specific activity and task. In the latter case, a set of research questions arising from the conceptual map help understand human-computer-human interaction when using PSS. In fact, the 25 *aspects* of EAST2 linked together in different ways by the *premises* can "map" different relationships. Hence, each research question asks something about how a subject aspect relates to an object aspect, thus many different questions could be formulated.

EAST2 theory can support the appropriate variables operational identification for each research question and implement studies to test the hypothesis. Jankowski and Nyerges (2001) conducted various case studies and laboratory experiment to test the theoretical framework. The research strategy adopted highly depends on the identified research questions (motivated by relevant premises), and on the data collection techniques. The studies reported in their book (Jankowski & Nyerges, 2001) were developed using the supporting technology available at that time which, unlike the case of such tools as Geodesignhub, were not able to recording and storing digital information on the planning process systematically. Hence, more or less pre-structuring techniques have been used to gather data about the *constructs* (variables) appearing in research questions.

In this context, the use of the data storage functions of Geodesignhub is proposed here to enrich the gathering data strategy of EAST2, as a complement to more traditional tools for data collection (e.g. survey, interview, video recording). Data recorded during a geodesign workshop held by the authors are, therefore, employed to test whether EAST2 can provide the theoretical basis to develop an operational framework for Geodesign process analytics. A set of research questions steaming from EAST2 framework were formulated looking also at what data the collaborative PSS Geodesignhub could offer in terms of analytical dimensions. In Tab. 1 an example strategy for a research question articulation is set out in detail.

PREMISE	RESEARCH QUESTION
Premise 5. Group processes (construct 5) have an effect on the types of influences that emerge during those processes (construct 6), and emergent influences affect the appropriation of influences (construct 4).	Does idea exchange as social interaction affect the emergence of group participant influence?

Tab. 1 The strategy for research questions articulation

In particular premise 5 states that group processes (i.e. decision and participatory strategies adopted) affect the emergence of new information, values, objectives, rules, and consequently change the appropriation acts (e.g. appropriation of group participant influence). Making these concepts and relationships explicit motivates the following research question: does idea exchange as social interaction during a participatory process affect the emergence of group participant influence? In order to test our assumption through an exploratory approach, variables were identified and selected from those recorded in the log-data of the geodesign workshop to develop Alternative Futures for the Metropolitan Area of Cagliari, Italy. Applying

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statistical analysis to the variables organized in the geodatabase, it was possible to explore the trend of the global evolution of the syntheses created along the geodesign process by each change team (Fig. 2a). The chart shows how the number of diagrams grows moving from the first to the third synthesis. As highlighted by Steinitz (2012) the first design synthesis is usually never the final one due to inherent limits of a first draft. Therefore, during the geodesign workshop, each of the six stakeholder groups was asked to shortly present its initial proposal and then to produce iteratively three rounds of revisions. Fig. 2b shows how in the early syntheses the teams focus more on systems according to their highest priority, while in the following revisions they broaden the scope of the design including diagrams from systems of lower priorities addressing new emerging issues. In fact, the Cagliari workshop, in the last two syntheses, four of six groups have selected a greater number of diagrams from those systems, that they have defined of medium or low priority following their initial objectives.

From the data analysis it is reasonable to assume that the iterative design process help the participants to enhance their understanding of the issues and opportunities for change. The presentation of the *syntheses* of the different team, although usually based on a different set of priorities may be a complementary but important part of the learning process within each team and among teams. Despite the fast pace with which these steps are carried on, the ideas exchange as fundamental phase workshop can i) facilitates dialogue and mutual learning between stakeholder groups as suggested by transactive planning theory (Friedmann, 1981), and ii) broaden the different shareholders' interests as it seems demonstrated by these first analysis.

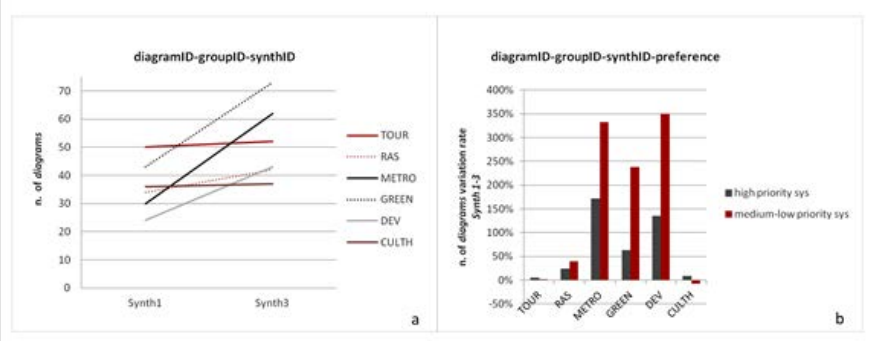

Fig. 2 Early quantitative measures of the GDH process dynamics. (a) Global evolution of the initial syntheses for each group; (b) variation rate of the number of *diagrams*, respectively in high and medium-low priority systems

3 CONCLUSIONS

This paper summarizes the early results of an ongoing research endeavour carried on by the authors aiming at defining a digitally based operational analytics framework for understanding planning and design processes. A new source of data, that is log-data gathered digitally during geodesign workshops thanks to the functionalities of the Geodesignhub PSS, was used to test the hypothesis. Early results suggests a huge potential for making value of available data for earning new insight about the collaborative design generation and about social design process dynamics.

Further research is definitely needed to define a robust geodesign process analytics, possibly leading to a better understating of general patterns and behaviours in planning and design processes. Nevertheless, early results suggests the possibility in the short-medium term not only to make past process more transparent,

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but also to monitor ongoing processes real-time assembling process performance indicators in digital dashboard. If this approach will give the expected fruits it may eventually contribute to gather new knowledge useful for the design of future collaborative planning and design initiatives through Metaplanning.

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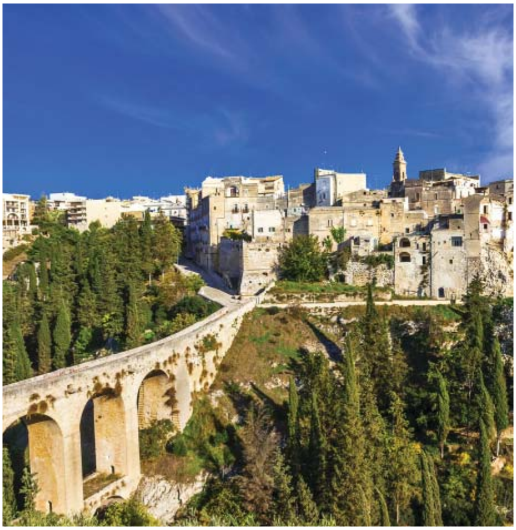

FACING URBAN REGENERATION ISSUES THROUGH GEODESIGN APPROACH

THE CASE OF GRAVINA IN PUGLIA

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ABSTRACT

Urban regeneration represents one of the main challenges for urban studies in the current decade. It is a complex issue strongly characterized by case study structural features or bindings, actors and beneficiaries, promoters and owners. Urban regeneration represents is an effective interdisciplinary scope combining instances characterizing architectural and technological disciplines but also social sciences and urban economy. Several approaches were applied in order to discuss success evidences according with effective design and implementation experiences. In this work, we discuss a peculiar dimension of urban regeneration approach, based on a specific meta-planning methodology: "geodesign". Investigating effective approaches in order to deliver inclusive and bottom up procedures supporting urban regeneration, we experimented geodesign by C. Steinitz in order to handle effectively a "negotiation process" among different stakeholders for the achievement of a shared strategic scenario for urban regeneration. The case study refers to Gravina in Puglia Municipality and, in particular, its historic center characterized by an extensive beauty of the urban traditional environment, with historical buildings partially renovated, and a settled in a unique landscape scenario: the "Gravina" canyon.
Results from this research are included in a participated renovation scenario for the historic center of Gravina municipality based on Geodesign methodology and assisted by Geodesign Hub (an online framework by Geodesign Hub Pvt. Ltd., Dublin, Ireland), delivered thorough a participative workshop organized on a deep territorial analysis of urban system and local community expectations.

KEYWORDS

Geodesign; Urban Regeneration; Negotiation Process

1 INTRODUCTION

Over the past few decades, the concept of sustainability has become a key theme of territorial development policies, which is why planning processes at any scale are articulated with specific reference to the territorial context in which the plans must operate. This context is identified not only with the natural or anthropized environment, but also with the system of public and private subjects that will be involved in the transformations induced by the plan and that often, due to their different cultural background and their role within of decision-making, can have different views on priority development strategies. The core problem between analysis and design creation is a problem of communication and shared understanding and is solved by effective collaboration between various parties involved in the design process (Ballal, 2015). Similar principles appear to be particularly relevant with regard to the innovations that the European Directive 42/2001/EC promoted in the process of drawing up the plan with the introduction of Strategic Environmental Assessment (VAS), but they are not always implemented satisfactorily in planning practices (COWI, 2009; Fisher, 2010). The methodological enrichment brought by the SEA to urban and territorial planning process is very close to the concept of Geodesign, which is therefore able to provide a useful guide for a profitable innovation in practices (Campagna & Di Cesare, 2014). Recent developments in the disciplinary debate on urban and territorial planning - in the United States of America, but also in Europe and Asia - propose the concept of Geodesign as a possible methodological framework for the project (Steinitz, 2012). Geodesign can be defined as the process of integration of methods, techniques and tools of GEO territorial information sciences to support the design and planning of physical development DESIGN. It can be described as a multidisciplinary collaboration with direct interaction among design professionals, geographically-oriented scientists, and the people of the place, using available information technologies (Nyerges et al., 2016). Geodesign proposes an integrated collaborative and participatory approach that starts from the conceptualization of the project and continues with analysis, simulation, development of alternatives, the evaluation of impacts and the choice (between the various phases). Central in Geodesign, is the role of methods and tools of geographic information sciences (Goodchild, 2010) which today, thanks to a great availability of data and processing services, allow the construction of dynamic cognitive frameworks constantly updated. The aim is therefore to explicate and strengthen the relationships between knowledge, decision and action in the project. The application of Geodesign appears to be more appropriate in a moment like the current one in which developments in information and communication technologies provide unprecedented knowledge bases and processing tools. Digital evolution begins, today also by norm, to involve the territorial governance processes too: the innovation of planning media is not limited to instrumental perspective, but generates profound implications of methodological and procedural character. Geodesign addresses these issues by highlighting the need to introduce models of representation, analysis, project, evaluation and choice, both in teaching and in professional practices, that are able to put into value the knowledge available to support processes, decision-making in the city and territory project.

Knowledge, technical rationality, transparency, traceability and responsibility are the basic objectives to be striven, especially in a historical moment in which decisions often based on mere contingent opportunities have caused unacceptable damages. If and to what extent a methodological approach such as Geodesign can succeed in ensuring effective support for the implementation of the principles of sustainable development, as well as a correct implementation of the strategic environmental assessment of urban and territorial plans, remains a hypothesis to verify with further experience in the field, but certainly can be a topic of relevance for research and training. The aim is contributing to a substantial renewal of the

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apparatus of the planner's techniques that today seems often unable to face challenges and problems of contemporary urban planning. The outcomes expected from a research agenda on Geodesign, may consequently also provide useful addresses to the renewal of academic curricula for the training of the latest generation planners.

Based on these premises, the paper deals with the integration of the Geodesign approach within a Planning Support System (PSS), for the development of an Urban Regeneration Plan (PRU) of the historic center of Gravina in Puglia.

2 CONTEXT - HISTORICAL CENTER OF GRAVINA IN PUGLIA

The Municipality of Gravina in Puglia is located in the Murgia area between Puglia and Basilicata, at the limit between the calcareous plateau of the Murge and the "Fossa Bradanica". It is therefore included in a territorial function system between Matera (European Capital of Culture, 2019) and Bari, which is going through an intensive tourist development perspective.

Fig. 1 Historic center view of Gravina in Puglia

The historical center is characterized by a vast beauty of the traditional urban environment, with partially restored historic buildings, and a settlement in a unique landscape scenery: the "Gravina." Various forms of settlements along the slopes of the Gravina on the calcarenitic outcrops have developed over the centuries. These settlements, which use the terraces as well as natural and artificial cavities, are the result of a close union between the geomorphological conditions of the places and the economic and social needs of the populations. The peculiar morphology of space has suggested the idea of recovery that takes shape through the principle of excavation and subtraction: ARCHITECTURE IN LEVING, consisting of digging and building in the same place, creating a sort of positive and negative: a city under the city. In fact, in ancient times, it was excavated in domestic quarries to use the material produced to build the above dwellings, such as the cave house, or cavati.

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Fig. 2 "Rupestre" architectures and multi-level organization of the settlement

The morphological characteristics of the Gravina make sure that this environment is affected by natural hazards such as landslides and floods, to which are to be added, given the presence of the inhabited area on the margins of the Gravina, dangers of an anthropic nature, including pollution and land degradation phenomena. The historic center is therefore characterized by the presence of important neighborhoods that are in a state of neglect and degradation, with the presence of abandoned buildings that show structural weaknesses. These situations have caused over the years: depopulation, environmental degradation, the isolation of some areas and, at the same time, the inaccessibility to them.

The historic center has been the subject of urban regeneration in recent years, with specific interventions in three main areas of the historic center: on Via Giudice Montea – Cavati, along the monumental axis and in the Fondovito neighbourhood. For a complete regeneration of the historic center, a recovery strategy that looks at an inclusive approach must be implemented.

3 LOGICAL FRAMEWORK APPROACH

Element characterizing this work was the choice to integrate two methodologies: LFA and GEODESIGN. While GEODESIGN is an operative support tool for the construction of systemic assessments and for the management of negotiation, the LFA appears as a rational tool for the ex-ante evaluation of critical issues.

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To complete the analysis and to identify the problems and objectives, we used the LFA methodology to support the planning of urban and territorial development interventions.
First phase saw the use of tools such as:

- SWOT analysis, for the identification of strengths, weaknesses, opportunities and threats;
- those of the program structure (problems tree and objective tree).

To illustrate the outputs of the methodology, we will comment on the Problem tree as shown in the next figure.

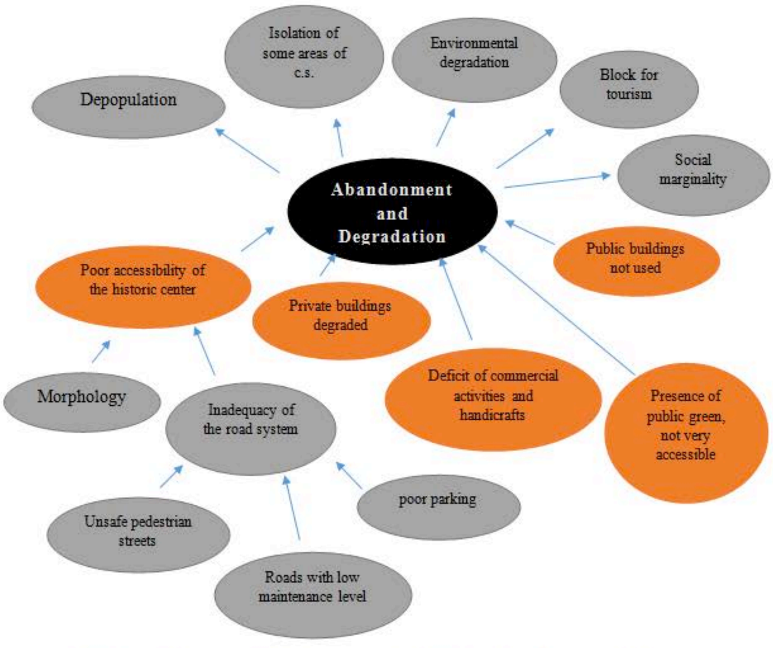

Fig. 3 Problem Tree

The problems tree we obtained, showcases problems of accessibility, the presence of abandoned and degraded buildings, the lack of craft and commercial activities, leading to a state of neglect and degradation, causing depopulation, isolation, environmental degradation and, last but not least, significant limitations to the tourist development of the area.

4 AN OVERVIEW OF THE FRAMEWORK FOR THE CONSTRUCTION OF A CHANGE PROGRAM

Problems

Currently the historic centre has different levels of degradation due to the decay and abandonment of the building fabric. The main causes are related to: inadequacy of infrastructural networks; social degradation, consequence of an alteration of the original social context and a strong depopulation.

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In general, the historic centre is lacking in public spaces and services.
The morphological characteristics of the roads impose restrictions on vehicular traffic. There are no adequate parking areas and pedestrian mobility is not very safe.

Program for Change
The municipality of "Gravina in Puglia", through a process of urban regeneration, aims to improve the habitability and liveability of the historic centre with targeted actions in the field of mobility, "green" infrastructures, protection and enhancement of natural environment, social policies and housing.
The interventions may concern one or more of the following types of actions:

- accessibility and sustainable mobility (promoting pedestrian and excursion practicability) through the recovery of paths, historical and internal roads to the historical centre,
- increase of territorial security (urban resilience),
- defence and enhancement of historical, architectural and environmental heritage,
- redevelopment, re-use and establishment of new urban functions in public and private building stock,
- sustainable tourism: favouring the establishment of tourist, cultural, commercial and handicraft activities.

It follows that the context of Gravina in Puglia is facing three important issues:

- tourism development;
- protection and enhancement of cultural and environmental heritage;
- recovery of residency.

5 GEODESIGN SYSTEMS

On the basis of the methodological framework defined by Steinitz and subsequently applied and revised in successive works (Campagna et al., 2016; Campagna et al., 2018; Cocco et al., 2018; Di Cesare et al., 2018; Moura et al., 2018), also carried out in very different territorial contexts from our own (Moura et al., 2016; Rivero et al., 2015), for the application of GEODESIGN we have divided the study area into ten systems that describe operational areas of intervention within which to call local actors to define proposals and alternatives.
Systems:

- green areas and environmental assets;
- cultural Heritage (churches, historical/architectural heritage);
- accessibility and connection (vehicular);
- walkability;
- urban functions: residence;
- parking area;
- urban functions: crafts;
- urban functions: commerce;
- urban functions: recreational activities;
- tourism and tourism services.

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Following the GEODESIGN methodology it was necessary to develop an evaluation model based on a land-suitability approach - LSA (territorial suitability analysis) where an evaluation map was created for each system. These maps show how a system is more or less susceptible to change, so if a project or policy applied on it is suitable or not suited to the system itself. Evaluation maps thus defined become the common knowledge base from which to start the design activities during the workshop. The systems and their maps are characterized and classified according to the colors (red / yellow / green), which indicate to the planner or the stakeholder that intervenes in the workshop, priority areas as characterized by a deficit situation from time to time. The colors used in the evaluation model and then in the maps are:

- (red), where the system already "exists";
- (yellow) is the lowest priority for change, an intervention is classified as "not appropriate";
- (light green) low priority intervention, "Capable";
- (green) has a higher priority, "Suitable" for processing;
- (dark green) is the highest priority for change, "Feasable".

6 GEODESIGNHUB.COM

Once the systems have been developed, then the areas on which to intervene were defined, we moved on to the configuration of the project on the geodesign.com platform developed by Hrishikesh Ballal, which allows analysis and planning in the geographical space, facilitating communication and negotiation practices among the participants. Hrishikesh Ballal provided the technical support necessary for the creation of the project within GDH. The first operation was to save the maps of the ten systems processed in QGIS, in geojson format, in order to load the maps on the geodesignhub.com platform, importing the ten evaluation models on it. Furthermore, a matrix of impacts was designed in which the possible effects (from very positive to very negative) were indicated, with a scale of five classes, that a project related to one of the ten systems could generate on each of the others. This matrix therefore identifies the interrelations between the systems and therefore allows to calculate in real time the impact of each design choice on the territory within the platform.

7 WORKSHOP GEODESIGN

The "Geodesign Workshop on Future Scenarios for Gravina in Puglia historical urban center" was held at the "Officine Culturali - Peppino Impastato" of Gravina in Puglia, on May 17, 2018, in the form of an intensive design day. One of the first phases of preparation of the workshop was the definition of the working groups, and therefore of the participants. Specific figures have been identified, for the most part local actors, who have always been shown to be citizens and operators active towards the "problem" recovery of the historical center. Competent professionals and experts in various methodologies, ready to experiment with new ideas and techniques were involved.

In this workshop we opt for a simulated approach, as the actors all have a medium-high cultural background with technical profiles. In addition, involving real actors would have entailed more time for preparation and selection, as well as an institutional commitment on the part of the administration which also had to be the protagonist of the urban regeneration process of the historic center of Gravina in Puglia.

It has also defined a "ladder" / agenda for the workshop, which shows the choice to compress the time of the workshop to avoid absences of some participants in several consecutive days, and also because the

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objective of the experimentation was more focused on the implementation process of the geodesign methodology.

Fig. 4 Whorkshop graphics

In detail, the agenda of activities includes:

- methodological introduction;
- description of the urban context, and representation of the systems;
- Definition of the actors involved
- Projects and policies on paper maps
- Insertion of diagrams in the platform
- Identify the change teams and explain the first shared scenarios
- Presentation of the proposals
- Coalitions
- Negotiation

The workshop was attended by 10 participants with different profiles: university students, entrepreneurs, freelancers and public administration officials. The participants were divided into teams, each with a specific role within the decision-making process, to form six different groups of stakeholders (stakeholders). After a brief presentation on the geodesign methodology, we moved on to the description of the study area, through an excursus on the implemented policies and future plans on the theme of urban regeneration in

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Gravina in Puglia. We then moved on to the presentation of the evaluation systems developed and the objectives of the workshop:

- tourist development;
- protection and valorisation of goods;
- cultural and environmental;

Each of the participants was provided with paper material for the workshop, ten tables on the ten evaluation systems, and an empty map of the historical center of Gravina, through which to start expressing their project evaluation, before moving on to inserting them in the platform. The interventions to be inserted could concern specific projects on a single building or a specific area, or through development policies. At this stage the participants were granted no more than 20 min. In fact each participant, through a practical example, was asked to elaborate a series of georeferenced conceptual diagrams, which represented specific policies or projects for each of the 10 systems, this is done through a sketch-planning tool available within the platform. Participants proposed additional policies and project diagrams based on stakeholder interests in the study area. They have drawn change diagrams such as points, lines or area polygons. The diagrams were added by the participants at any time to the design database and were shared when working in collaboration mode. Policies have been developed as cross-hatched areas; however, only the projects were assessed for their direct impact. During this phase, more than 80 diagrams were processed automatically organized by the platform in an abacus ordered by reference system.

After inserting the diagrams, two Change teams were created, made up of similar figures of interest, each change team proposed scenarios of change.

Fig. 5 Workshop activities in the negotiation phase

The assessment of the performance of each scenario enabled us to visualize its weaknesses and has triggered a virtuous process through which each group has modified some of its design choices, in order to minimize the negative impacts or to reduce the realization costs.

The two alternative development scenarios, one for each of the two groups of stakeholders and proposed at the end in the last synthesis cycle, were then evaluated comparatively in a summary screen, in which not only the project alternative can be viewed, but also its possible impacts and cost analysis.

<u>Negotiation scenery</u>

The last phase of the workshop was oriented to the construction of a project proposal shared by all the participants, reached step by step, through dialogue and negotiation.

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The scenario shows how more interventions have been selected on the cultural heritage system and many less choices on craftsmanship. Moreover, it was noted that among the groups, the projects and the policies in the two plan alternatives are concentrated mainly in the same areas, presenting numerous correspondences and some discrepancies. Similar similarities have facilitated the negotiation process and the construction of a scenario shared by all the stakeholders.

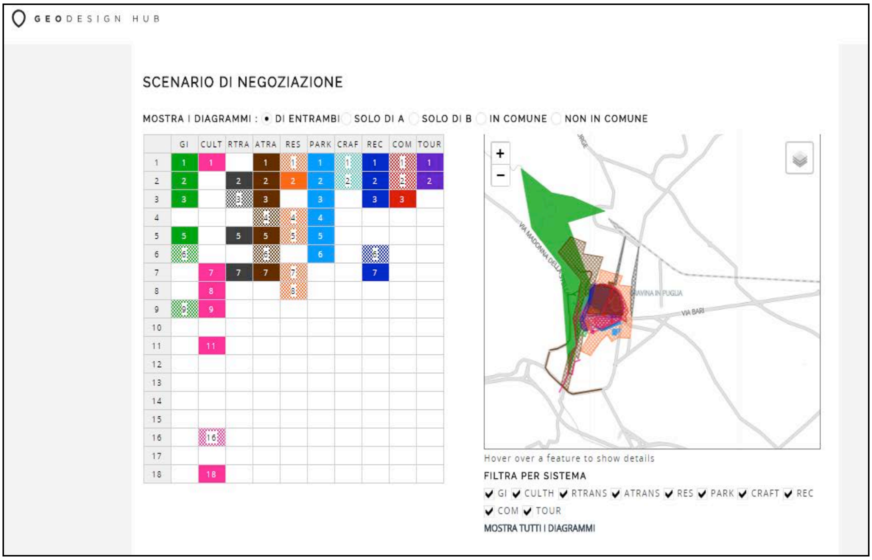

Fig. 6 Geodesign HUB - Negotiation scenario

8 CONCLUSIONS

The case study allowed to combine two methodologies: the LFA in the cognitive phase and context analysis, the Geodesign to support the participatory process aimed at negotiating a strategic vision among local actors. Precisely the experience of the workshop was conducted with a selected sample of participants, composed mostly of young professionals, and students, actively engaged in the analyzed context.

It is therefore a case of "simulation" of the process of definition of alternatives, in which each technician has worked within the discussion groups according to a point of view of a certain category of stakeholder assigned by the workshop leader. This has allowed a simplification of the process: it is the case in which the participants had no difficulty in interacting with the platform in full autonomy with competence regarding the insertion of associated geographical information and project proposals (diagrams); the conflict between alternative positions has been blunted in relation to the level of competence of the participants and their ability to foreshadow the negotiating solution.

However, in current spatial planning practice characterized by a relevant complexity mainly linked to the multi-dimensional context characterizing its processes (Cocco et al., 2018), it has been demonstrated how the use of Geodesign as a dynamic methodology that stimulates and directs interaction and collaboration, is well suited to be applied to tackle complex problems involving a multitude of actors of different backgrounds. Geodesign effectively supports complex processes making it possible for stakeholders and

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communities in devising and choosing sustainable future development scenarios for their territories (Campagna, 2016). The method is obviously malleable, can be applied to large areas, metropolitan areas, cities, neighborhoods or even small-scale. What characterizes it is the ability to receive indications from planning experts design professions (urban planners, architects, engineers) specialists geografic sciences (economists, agronomists, geologists, environmental engineers, experts in territorial security, energy, environment, etc.) people of the place therefore experts of the territory (citizens, administrators, inhabitants of the place) to put them to system through an online application infrastructure that visualizes and allows the interaction and that interfaces with other applications.

The use of the online collaboration platform GDH also facilitates, during the initial phase, the management of a planning process of considerable complexity as it could be that related to the recovery of the historic centers up to reach large area scenarios, which provide more objectives, different unknowns and the need to create and evaluate heterogeneous project alternatives.

So "the platform works" because:

- dynamic iteration and collaboration;
- adapts to the digital user;
- it is easy to learn;
- it is entirely online and therefore also adapts to support remote interaction between users connected on the network.

Instead, they represent elements of criticality of the experience carried out within this work:

- the tight schedule, and duration of the workshop, which needs at least two or three intensive days;
- the need to give more space to the description of the outcomes of the context analyzes, or to discuss them on the merits, within moments of public discussion preliminary to the workshop, in order to overcome the exclusively technical approach in defining the basic maps and achieve a collective learning process;
- real stakeholders and - probably - more moderators / facilitators;
- decision makers and public commitment as a guarantee element for the realization of the strategies obtained through the workshop;
- the user with a lack of familiarity with ICT tools can experience a participation gap;
- Compared to what emerged during the negotiation phase, the weakness of the descriptive detail of the projects / policies that allows an adequate comparison between the participants is a critical element.

<u>Developments and potential applications</u>

Geodesign as a laboratory / tool for monitoring and evaluating transformation processes would also be useful during the implementation phases of an intervention program:

- to define supply chains complementary to the public action of regeneration of collective spaces;
- to inform and share choices with the user community;
- sharing information - including technical - on timing and implementation methods in order to activate the initiative tested in specific areas (i.e. tourism).

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A GEODESIGN PROJECT ON POST-EARTHQUAKE REHABILITATION

CO-DESIGNING A STRATEGY FOR NORCIA

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ABSTRACT

Natural disasters have been always destabilizing urban systems. Researchers are foreseeing a substantial increase in terms of frequency and intensity of undermining events in the coming future. In the Italian context, communities have commonly relied on planning measures mostly focused on the mere physical reconstruction. Besides the increase of public audience engagement in contexts of stability, post-disaster planning is lacking efficient collaborative processes that are usually non-existent and when rarely applied, are commonly ineffective. The research intends to test and explore the development of a negotiated and agreed rehabilitation strategy for Norcia, a small Italian city that has been hit by seismic events (2016), damaging its key infrastructures and assets. Being the study primarily process-oriented, it has the objective to investigate the development of planning solutions (projects and policies) with particular focus on sustainable and preventive measures, both in a short and long-term perspective, through a co-designed decision-making process. The study is therefore, primarily focused on the process itself, rather than being solution oriented. The core method refers to the Geodesign methodological approach and the Geodesign hub collaborative tool. Results demonstrate that a collaborative early stage post-disaster strategy can be rapidly achieved with local actors using modern technology. Adopting a systemic approach integrated together with visualization tools can facilitate the collaboration among stakeholders by generating a better understanding of territorial issues, providing a common language.

KEYWORDS

Geodesign; Natural Disaster Rehabilitation; Interactive Collaborative Engagement

1 INTRODUCTION

Global population is experiencing a fast growing rate that directly affects the way of living and adapting to the changing conditions of the planet. From a planning perspective, this challenging issue is commonly related to the evolution of human settlements and natural systems, which are faster developing new and more complex forms of mutual interaction. Communities are also increasing awareness of upcoming challenges and vulnerabilities caused by this operational intricacy between the natural and the built environment, claiming to be actively included in significant decisions over the future of their places.

Although community engagement is increasingly supported by the evolution of technologies which are becoming more accessible for a larger number of people, democratization of post-disaster planning practices is still struggling to emerge, especially in the Italian context. Given the fact that along with climate change issues earthquakes are becoming more frequent and more impacting on territorial systems, traditional post-disaster planning approaches urgently need innovative and more comprehensive perspectives to be put into practice. In 2016, the rural town of Norcia was one among many others impacted municipalities in central Italy, facing human losses, economic stagnation and depopulation. The main local economic systems have been deeply destabilized, as well as food production and tourism, on which the entire community relies on.

Therefore, a geodesign study on the Norcia municipality has been conducted by a multidisciplinary team for testing the potential of an innovative planning approach in such circumstances. The objective of the project (mainly process-oriented) was to investigate on the co-creation of coherent and comprehensive rehabilitation strategies able to address functionally short-term interventions for long-term goals.

The design approach adopted during the research refers to the Geodesign Framework (GD) developed by Steinitz (2012) and the Geodesign Hub tool. Steinitz (2012) formulated his holistic methodological framework, defining design strategies focused on a system-thinking, multidisciplinary, multiscale approach, shaping participatory procedural techniques, while coordinating short and long-term goals. Indeed, it is widely recognized that Geodesign is "a new approach to design and decision-making in urban and regional planning which is deeply rooted in the geographical sciences" (Campagna et al., 2016). This innovative approach has the "capacity to promote a unified, collaborative, and mutually agreed design, as a result of a multidisciplinary environment" (Rivero, 2015). Concerning the operationalization of the methodology, it has been used the Geodesign Hub (GDH) software developed by Hrishikesh Ballal (2015). The tool (geodesignhub.com) is a cloud-base open system that facilitates negotiation among stakeholders, guiding the users in an interactive digital workflow wherein participants propose their conceptual design and through the tool, directly inform the decision-making process (Nyerges, 2016; Rivero, 2015). Overall, a GD process is characterised by a workflow, which starts with contextualizing and assessing the territorial conditions of a certain study area and ends with the co-creation of strategic guidelines that will inform further plans. Therefore, to set up a GD project, the Steinitz's framework requires to follow a flexible but structured passages described in 6 models. The first three models provide an assessment of the territorial conditions by thoroughly analyzing the territorial context (Representation Model), its transformation dynamics (Process model) and the evaluation of its strengths and weaknesses (Evaluation Model). While, the remaining three models carry to the design of the intervention phase, aiming to identify how the implementations will affect the territorial dynamics. This stage is divided into the co-planning of alternative scenario (Change Model), its impact evaluation (Impact Model) and the co-creation of agreed guidelines (Decision Model) for the development an area (Di Cesare et al., 2016). The procedural continuity among the six models permits to re include an output in the process as a starting input for the sequent phase. The first three models mainly

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investigate past and present conditions of the study area even though Process model might also simulate future trends, while the last three are concerned about the future ones (Steinitz, 2012). The paper seeks to explain the practical application of the six models dividing the whole process into three sections, furtherly described in the text: process input, collaborative workflow and outcomes.

2 PROJECT INPUT

The overall geographical understanding of the study area helped to identify the prevailing characters and key spatial elements that constitute the Norcia's territory. So that, considering its geographical and historical context, socio-economic dynamics, local characteristics, current and future challenges, the geodesign team decided to represent (representation model) the territory by taking into account the following ten systems and their variables: Ecology (ECO), Agriculture (AG), Public Spaces to support Civil Protection (SPPC), Cultural Tourism (C-TUR), Residential Development (RES), Commerce and Industry (COMIND), Ecologic Tourism (E-TUR), Transport (TRASP), Energy (EN) and Priority of Intervention (PRI). Among all the other geo-information, an important technical aspect considering the seismic context of the case study is the inclusion of the Geological Risk Index (GRI) as a fundamental information in the geoprocessing (process model) for the construction of most of the systems.

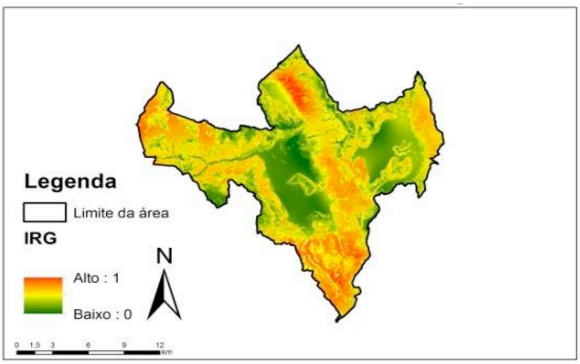

Fig. 1 Geological Risk Index (Casagrande et al., 2017)

The proposed GRI includes four variables: slope, length-gradient stream index, hydrogeology and structural geology. By assigning different weights in matrix algebra, three large compartments with a considerable potential for mass movement have been identified (Casagrande et al., 2017). Moreover, the E-TUR system has been built with the support of the Interactive Visualization Tool (InViTo) software developed by the Higher Institution on Territorial Systems for Innovation (SiTi). InViTo (urbantoolbox.it) is an open collaborative web-GIS toolbox for building spatial knowledge which aims to guide users in building their spatial knowledge and awareness by means of high interaction with dynamic maps, in order to allow decision-makers to be informed before making their choices (Pensa, 2012). Operationally, among several applications, the tool allows users to assign different weighting values to a pre-set number of variables that after being integrated, generate a result, which visually reflects the adopted logic behind it. The tool was applied for the purpose of objectivizing the construction of a system's information, based on data subjected to personal weighing interpretations. The E-TUR system was chosen due to its data grounded in touristic activities suitability, which are information highly susceptible to subjective preferences, a fact that radically

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changes the final system construction according to the person in charge of assessing it. As a result of the geo-processing phase, the ten evaluation maps (evaluation model) have been constructed. They stand as geographical knowledge that shall guide the participants to understand where is more feasible or either not appropriate to intervene, supporting the management of the co-design phase.

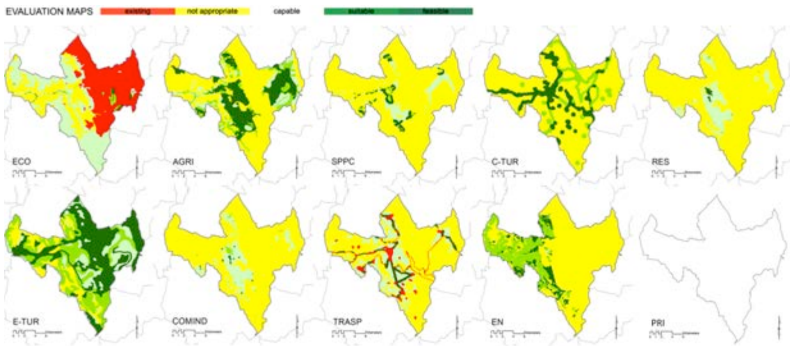

Fig. 3 The 10 evaluation maps

The color-codes classification simplifies the visualization of complex territorial dynamics by identifying and ranking from dark green the most adequate parcels to be interested by an intervention or variation, to light green for less adequate areas, according to the system. Secondly, yellow colour represents those parcels with lowest attractiveness, which are not welcoming interventions due to physical characteristics, constraints and costs. Instead, red colour emphasizes that the existing elements and conditions within an area do not require further implementations because well-functioning at the moment of the evaluation. Once all the systems setup were finalized, the impacts have been set in an excel sheet comparing the effects of one system on another (Fig. 4).

			SYSTEM EXISTING CONDITION									
		System #	1	2	3	4	5	6	7	8	9	10
			ECO	AG	SPPC	C-TUR	RES	E-TUR	COMIND	TRASP	PRI	EN
System #	SYSTEM CHANGE											
1	ECO		ND	-1	0	-1	-2	2	-1	-1		-1
2	AG		-1	ND	0	1	-1	1	1	0		0
3	SPPC		0	0	ND	0	-1	0	-1	0		1
4	C-TUR		0	0	0	ND	2	1	1	0		0
5	RES		-2	-1	0	0	ND	0	-1	0		1
6	E-TUR		2	2	0	0	0	ND	0	0		0
7	COMIND		-2	1	0	2	0	0	ND	0		2
8	TRASP		-1	1	2	1	1	1	2	ND		0
9	PRI										ND	
10	EN		-1	0	0	0	2	0	2	1		ND

Most positive, best · Positive, good · Neutral · Negative, bad · Most negative, worst

Fig. 4 Impacts matrix

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The matrix has been built by assigning a value ranging from +2 (most positive) to -2 (most negative), considering how eventual physical implementations within each system may impact on all the other systems. Operationally, the matrix results will be successively computed, directly informing the further phases.
Also a 3D model of the area has been built and provided to participants during the collaborative workflow, enabling a better understanding of the local morphology in order to visually assist stakeholders throughout the decision-making phase.

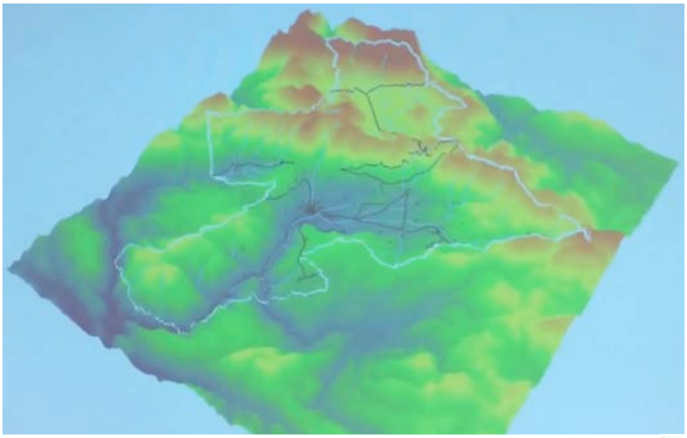

Fig. 5 The 3D Model

3 COLLABORATIVE WORKFLOW

At the one and a half day workshop event hosted by the University of Perugia, eleven people actively participated. The compositions were:

Quantity	Role	Institution
2	Professor Student	Department of Political Science, University of Perugia
1	PhD Candidate	Department of Physic and Geology, University of Perugia
2	Engineers	Civil Protection
2	PhD Candidates	Gran Sasso Science Institute
1	Civil Engineer	Private
1	Architect	Private
1	Student	Department of Architecture, University of Rome
1	Expert	Agriculture-related local onlus

Tab. 1 List of participants

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Besides their interests and professions, most of the participants listed above were either citizens or experts of the study area. For the sake of the project, the geodesign team had the task to coordinate and supervise both the overall workshop flow and the participants’ responsiveness, monitoring the creation of strategies in the form of drawn diagrams and providing technical support. A conductor from the geodesign team was able to assist the whole collaboration throughout the process.

After a brief explanation of the conductor about the GDH functionalities, participants logged-in and got familiar with the GDH interface and started to use the software. It is provided the following scheme to simplify the workflow for a better comprehension, going from the evaluation maps (input) towards the final agreement map (output).

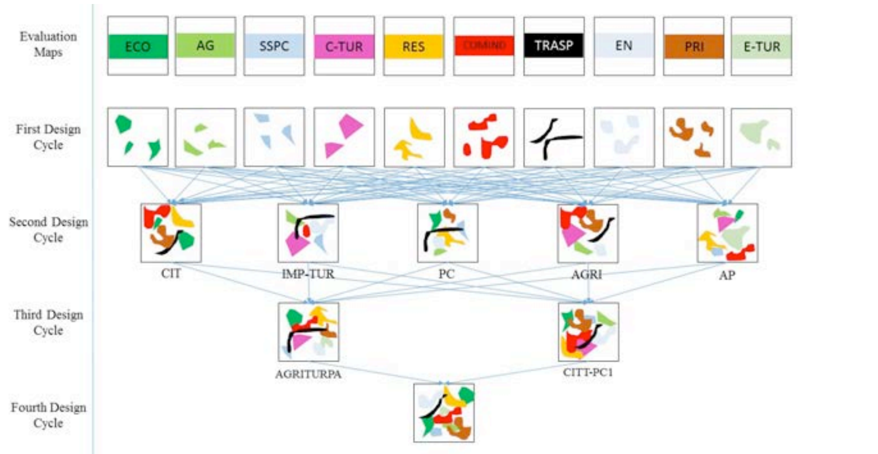

Fig. 6 The collaborative workflow scheme

During the first design cycle, through the use of sketch-planning tool, it was asked to the groups’ members to create a number of diagrams (projects and policies) for each system directly onto the geo-referenced evaluation maps (change model).

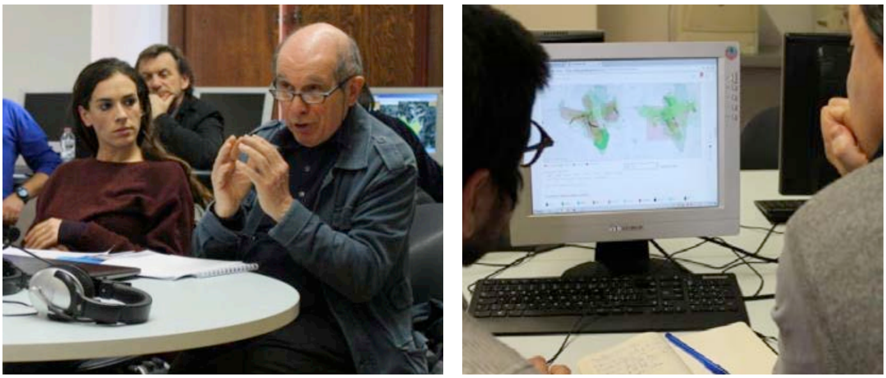

Fig. 7 Proactive engagement encouraged by the use of interactive maps

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Fig. 8 Moments of the collaboration

Practically, after an initial consultation to better define the territory, during this first design cycle, participants displayed the evaluation maps on the GDH interface, and began to draw their strategies into the software which simultaneously shows the diagrams proposed to everyone. Concluded the first drawing session, all the diagrams have been automatically organized in a matrix where were sequentially visualized according to each system's relation and chronological order of creation. For the second design cycle, participants were arranged in five new groups, each one representing a category interests. The five groups included the Tourist sector entrepreneurs (IMP-TUR) group, the Citizens (CIT) group, the Civil Protection (PC), the Agricultural entrepreneur association (AGRI) and the Public authority (AP) group. Successively, it was required to each group to set their histogram weights according to their systems' preferences (decision model). The decision model histogram (Fig. 9) is basically an interactive bar chart that represents the group interests considering each system, prioritizing them by associating a value to each bar on a scale from 1 (almost negligible) up to 10 (highest interest), according to their planning role. By discussing objectives, locations, impacts (impact model) and costs, each of the five groups internally negotiated a common strategy, reconsidering the most contested diagrams. The selection of the accepted diagrams (existing, edited or new) have been updated in the previous matrix and displayed in real-time, composing the group synthesis map. The first day has concluded fulfilling the sociogram that is a matrix mutually assessed by the five groups where they expressed their agreement or disagreement to collaborate with the other groups, considering possible synergies and conflicts between both the synthesis maps and the decision model histograms. The new groups have been therefore composed: AGRITURPA (AGRI; IMP-TUR; AP) and CITT_PC_1 (PC; CIT). The second day, started with the third design cycle among the two groups and therefore the negotiation phase allowed for the definition of only two synthesis maps. Thus, the fourth and last cycle started by merging the two groups into one, heading to the creation of the last synthesis map that tangibly represented the suggested plan which maximizes the consensus. To briefly summarize the workflow, during the first design cycle, the participants individually planned a series of strategies by sketching diagrams for the ten systems, considering the respective evaluation maps. During the second design cycle, the participants were gathered together in five groups which created a synthesis map each by either selecting and editing the diagrams from the first cycle or creating new ones. Consequently, according to sociogram that took into consideration synergies among stakeholders, the five groups were merged into two, beginning the third design cycle which led to only two synthesis maps.

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The fourth and last design cycle begun with merging the two groups in only one where, through the final negotiation phase, the co-created agreement map was achieved.

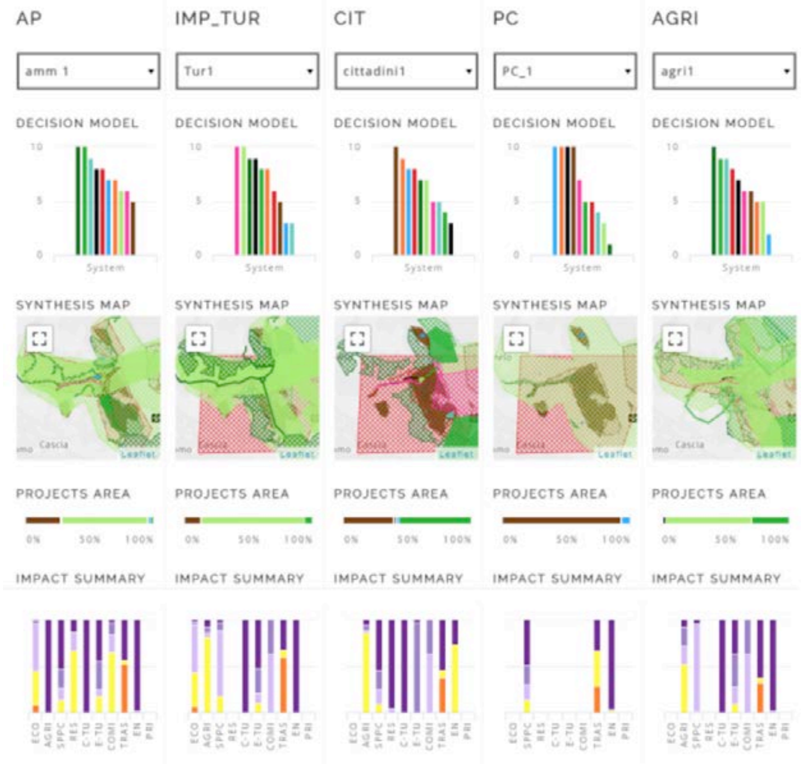

Fig. 9 Decision, Change and Impact models

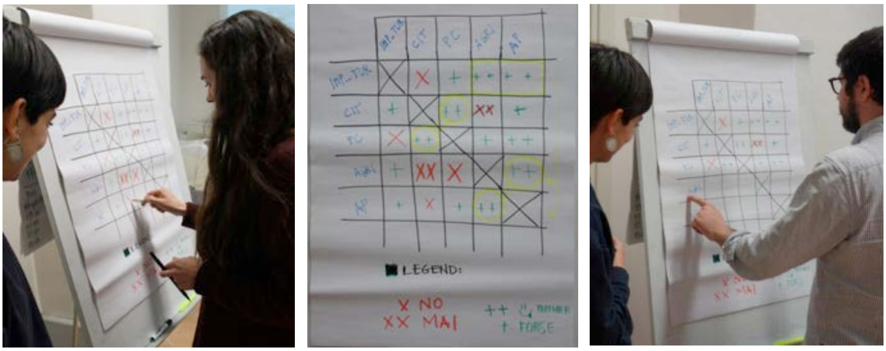

Fig. 10 Filling in the sociogram matrix

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4 OUTCOMES

The overlaying of the total chosen diagrams from all the ten systems form the final outcome of the collaborative workflow. Along the collaborative workflow participants have iteratively negotiated 113 diagrams, of which 45 compose the final scenario.

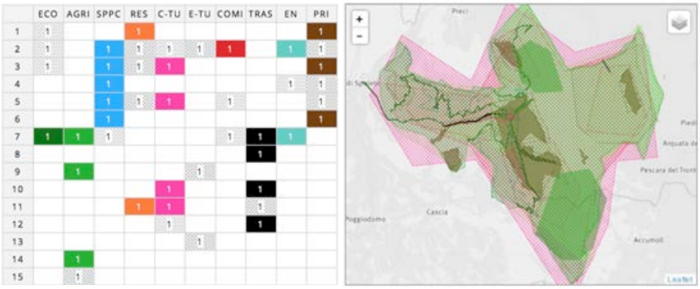

Fig. 11 The diagram matrix and the final strategy map

The 45 final diagrams are shown in the matrix on the left, composing the final scenario strategy map which is visualized on the right. Looking at the (Fig. 11) above, there is a certain homogeneity regarding both the balance between policies and projects, respectively 20 and 25, and the amount of diagrams per system, ranging between a minimum of 3 and a maximum of 6. From a design perspective, analysing the strategies proposed, participants opted for solutions targeting to avoid economic stagnation by maintaining local productivity and jobs, enhancing the overall local natural and built environment connectivity. Urban densification pattern together with short and long-term anti-seismic measures (preventive and mitigative) were prioritized, targeting to reduce the overall vulnerability while introducing energy transition solutions. Moreover, from a negotiation perspective, referring to the diagram performance, there was an increase of agreement throughout the final negotiation phase, emphasizing a rapid maximization of the consensus. Finally, it is observable that the application of software and visual tools assisted the participants' comprehension of the territorial needs while dealing simultaneously with short and long-term goals, also digitally supporting a multidisciplinary and cross-generational interaction.

5 CONCLUSION

The paper summarizes the Norcia case study which investigates the applicability of the co-planning principles defined by the GD methodology and the GDH tool for testing whether the practice lend itself to face complex planning post-disaster rehabilitation challenges. The overall results highlight that through the collaborative negotiation phase, the initial conceptual project objectives have been generally respected, pushing towards contextualized rehabilitation measures (physical interventions and policies), prioritizing them within the pre-set 20-year time horizon. The innovation of the GD methodology with the GDH tool relies on an (inter)active engagement of the local community based on negotiation, where people are not simply informed of decisions often previously taken but they would rather contribute by directly influencing decision-making processes since the beginning. The methodological models together with the dynamicity of the digital visualization play a significant role in enhancing agreement among participants. It increases the overall procedural consensus and activates cross-generational collaborations facilitated by the GDH user-friendly interface. The complexity of such context is unfolded through an integrated multidisciplinary and

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multi-scale system-thinking approach. Indeed, the tested GD characteristics reflect the open call for new innovative planning practices and tools according to the principles of the most recent normative (Ordinance n.39, 8 September 2017) concerning post-earthquake planning for the centre of Italy. The investigated methodology leads to a manageable collaboration among stakeholders, fostering the creation of fast, comprehensive, mutually-agreed rehabilitation guidelines that should coherently inform further plans. Therefore, the GD methodology, being operationalized and facilitated by the digital support of GDH, can enhance stakeholder collaboration, bringing improvements to post-disaster planning practices while dealing with high complexity, as for the case of Norcia.

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AUTHOR'S PROFILE

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Emil Lanfranchi, graduated in Urban, Landscape and Environmental Geography at Bologna University (2009) and specialised in Engineering of Sustainable Cities Development at the Aalborg University (2017). My research in the area of collaborative decision-making processes is based on holistic competences which find their application in Geodesign projects, since 2016.

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COMPLEMENTARY WEB-BASED GEOINFORMATION TECHNOLOGY TO GEODESIGN PRACTICES

STRATEGIC DECISION-MAKING STAGES OF CO-CREATION IN TERRITORIAL PLANNING

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ABSTRACT

The teaching of territorial planning requires students be trained in geo-information technology tools. The practice was held on engineering course in the University of Bologna and intended to train students in the use of geodesign methods to co-create alternative futures proposals for a territory by applying the framework proposed by Steinitz and using the GeodesignHub web-based platform. The method assumes the construction of representative and evaluative models about the place before the workshop stage, when users are put in contact with data already produced. In order to avoid misunderstanding, noises and encouraging active participation during the workshop, sharing-decision mechanisms using web-based geo-information technology tools were tried, adjusted for the expressive capacity of young millennia in the use of digital social media. As methods, we explored the possibilities of Crowdsourcing Mapping to gather information about main characteristics of the area, WebGis to share georeferenced maps and favor combinations of variables, Delphi method to maximize consensus, Geo-questionnaires for territory evaluation, Word Cloud and Hashtags for ontologies association of design ideas. The case study was Faenza, in Emilia-Romagna, since we had access to VAS data and assessments for the region. As a result, the interest and quality of participation in the co-creation workshop for the area was significantly increased and it was possible to observe the easiness of understanding the processes, due to the improvements applied in language visualization, so that the experience favored the development of knowledge and skills.

KEYWORDS

Territorial Planning, Geodesign, Web-based Tools; Visualization, Co-creation

1 INTRODUCTION

The development and popularization of geo-information technologies have significantly transformed the methodological processes in urban planning. Since the creation of GIS - Geographic Information Systems, the expansion of resources has been observed in the production of data, in the transformation of data into information, and in the possibilities of transforming information into knowledge. In the last decade, a new phase in these technologies is highlighted, with the inclusion of the possibilities of the world-wide computer network as a working platform, which results in the beginning of the popularization of the production and use of georeferenced information, bringing a new era in methodologies of spatial analysis and planning.

Geographic Information Systems were born in the 1960s in Canada, based on desktops and intended only to those who had specific knowledge in the subject, because it was necessary to comply with the first technical steps of development. A GIS, according to Burrough (1986) should fulfill the functions of favoring the acquisition, storage, retrieval, transformation and emission of spatial information. The systems are based, according to Aronoff (1989) on the use of spatially referenced data, and are structured in actions of input, management, manipulation, analysis and output of georreferenced data.

The first challenges, in this sense, were to overcome the steps of organization, disclosure and access to databases on local computers or internal networks. Peuquet and Marble (1990) classified the initial stages as "process-oriented approach", "application approach", "toolbox approach" and "database approach". Then, according to Moura (2015), the challenge was to invest in "visualization approach", based on investments in visualization that favor that the users participate in the stages of spatial analysis in a more conscious way and understanding better their choices.

We are facing new paradigms in the use of data, due to changes in the platforms for geo-information technologies. The group of users is expanding, and nowadays those who work with GIS science are not restricted to technicians who have expert knowledge, but all the citizens that need to have access to georeferenced information. The platforms leave the sphere of the desktops and install themselves in the world-wide network of computers, on the web. In this sense, the two changes complement and make possible: web access and citizen interest, one enhancing the other.

In spatial and urban planning, spatial analyzes have become more robust based on the use of geoprocessing resources and, more specifically, the application of models made possible by the use of Geographic Information Systems. Spatial analysis models favor the representation, visualization, evaluation and simulation of combinations of variables, constructing diagnostic and prognostic analysis. According to Moura (2012, 2014) the intention is a broad support for decision-making. But these decisions need to be shared, as this is a contemporary value in territorial planning.

It is believed, therefore, that the full employment of GIS potential should advance in the production of information from the existing data, favored by the use of a logical structure to build information to support decision-making. The interest in methodological processes in decision making on alternative futures of a territory supported by geoinformation technologies has been in the focus of the attention of planners since 2012, when the logic of Geodesign, design, design "with" and " for "the landscape. Geo - land / territory + Design - design, project (Batty, 2013; Steinitz, 2012).

For Miller (2012) the logic of Geodesign arises in the studies of landscape planning, following a thought already presented by McHarg (1969) in "Design with nature", through which the territory is interpreted according to its components or main variables and the arrangement between them. The variables are organized into information plans and their combinations are performed to identify the areas of constraints

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and potentialities to the uses, vulnerabilities and attractiveness. Steinitz (2012), who teaches landscape planning since the 1960s, has developed methods for integrating actors, actions, variables, and decision-making processes into territorial planning at different scales.

For the application of the logic of Geodesign, Steinitz (2012) proposed a framework, a logical structure applying geo-technology resources. The methodological framework is structured in work stages, with the purpose of supporting the characterization, analysis, evaluation of potentials and constraints, simulation and prediction of future possibilities for an area. However, the most important phase is the stage of elaboration of proposals of projects and policies for the territory, carried out in actions of decision making. Throughout the methodological process there is a strong inclusion of the visualization component to support decision making. The logic is the co-creation, in co-design of alternative futures for the territory. The urban plans are not only technical, but are also decoding of collective values, avoiding the top-down plans, and proposing methods to listen to expectations from different actors. But the technical opinion continues to have value, so it is necessary to put together the technical, the administrative and the people of the place. The digital platforms that support the process need to be well structured and favor the broad understanding by all groups of participants. They also need to make the role of the actors involved clear, the tasks to be accomplished, the moments of review and evaluation, the moments of decision making.

Steinitz's proposal for Geodesign presents a framework to allow this collective participation in steps. Thus, the author proposes a framework with six action stages that happens throughout the models of representation, processes, evaluation, simulation, proposition and decision. A landscape intervention project, such as urban landscape planning and management, follows the steps of answering these questions: How can the area be represented? How does it work? Is it working fine? How can it be changed? What impacts can the changes cause? What should be proposed for the area? (Fig. 1).

Steinitz's proposal can be developed even on an analog platform, by overlaying maps and designing landscape change proposals, but the dynamics and co-creation of designs are much more optimized if users work on a digital platform in which they have simultaneous access to the information and dynamically visualize results of the proposals. To support this dynamic, web-based platforms are the most appropriate. In recent years, the author has worked mainly on the GeodesignHub platform, developed by Hrishikesh Ballal (Ballal, 2015). In this platform the participants have contact with the main systems that characterize the potentialities and limitations of the study area, elaborate proposals of projects and policies for each thematic contained in the systems, and gather these proposals in the form of designs, which have the Master Plan character of ideas for territorial transformation. From experiences in different scales of approach, we observed some challenges to be faced, so that the users had their optimized participation, felt comfortable and confident in the different stages, and this security should come from the amplification of the conditions of understanding the information. The criticisms observed in previous experiences, for which studies of the application of additional mechanisms have been developed. They were:

- understanding the composition of the systems, and the content portrayed in the systems. Investments in the graphical treatment of information and the presentation of information (Zyngier et al., 2016);
- possibility of using data of different origins and use of data produced in the Geodesign process in other platforms, so that users could choose languages and platforms where they feel more comfor. This means investments in interoperability between systems (Moura et al., 2016);
- adaptation of languages according to the values of different groups of users, investing in mechanisms of local reality visualization, such as the three-dimensional modeling resulting from data capturing that

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favors the relationship between system maps, mental maps and observed reality (Monteiro et al., 2018; Zyngier et al., 2017);

- the importance of allowing users to understand the main components/variables that characterize the study area, and prepare them to give their opinions in the proposal elaboration workshop (Casagrande & Moura, 2018).

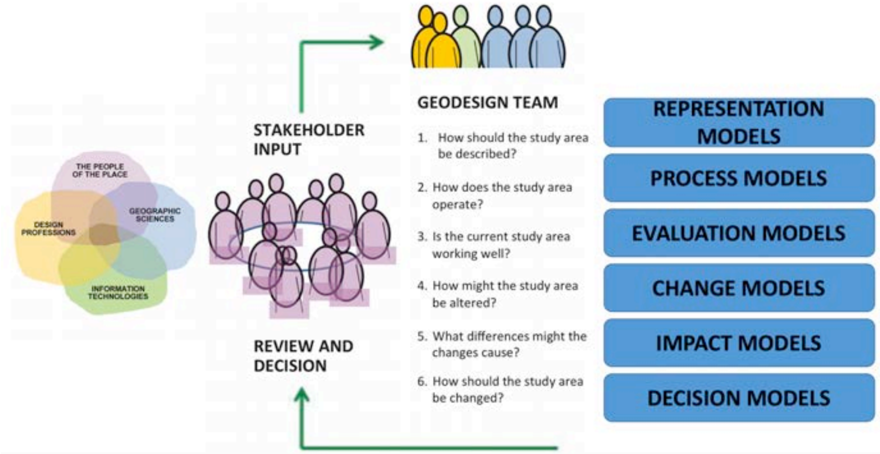

Fig. 1 Steinitz's framework for Geodesign (adapted from Steinitz, 2012)

From these experiments of expansion and adjustments of the possibilities of the Geodesign, the case study of Geodesign Faenza was developed, whose workshop was held at the University of Bologna, in an academic context, in 2017. The objective was to train engineering students in territorial planning with the use of geo-information technologies. The spatial cut was the municipality of Faenza, because one of the teachers involved worked in the VAS (*Valutazione Ambientale Strategica* – Strategic Environmental Assessment) of the region and presented extensive knowledge and data about the territory, and the municipality is located in the area of influence of the University of Bologna, Emilia-Romagna.

The methodological approach was to increase the use of the web platform in several work stages, due to the recognition of the new stage in the use of geoinformation technologies that are migrating from the desktop platform to the global computer network. The conceptual cut was the adoption of languages that could be more easily captured by the generation of young students, the so-called "Millennials" (generation Y), so that they could participate in activities intuitively and learn from experience. The time cut was the insertion of the workshop and the explanations about Geodesign in territorial planning during 4 meetings of an undergraduate course, one of which was devoted to the preparation of data and recognition of the area, two for the workshop and one for the conceptual basis.

The main challenge, which was the main methodological contribution of the case study, was the work in the language of the generation Y students and the use of different web-based applications to support each step of Geodesign. According to Prensky (2001) the generation Y is one that was born at the turn of the 21st century and reaches maturity at the beginning of the century. It is a generation that is born inserted in digital tools, being called digital natives. For them everything is online and technology is something natural.

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They are all native speakers of the digital language of computers and the Internet. Thus, they have a special role in society, which is to translate this new language to previous generations, favoring them to be included in the new collective platforms, since this is the media where decisions are already being made, which tends to expand. In that sense, teaching Geodesign to Millennials requires new processes, but testing with these youngsters would also give us answers to new visualizations to be used in other future workshops.
In this sense, the case study had the following objectives:

- to develop an academic workshop to train students of generation Y in the use of geo-information technologies for territorial planning, in collaboration between the EA-UFMG Geoprocessing Laboratory and the University of Bologna, a civil engineering course;
- To observe the performance of the members of the generation Y in the use of a set of web-based applications that would favor the virtual knowledge about the territory of analysis, the manifestation of opinions on the case study and the learning of the collective construction of a Master Plan for the area;
- propose and test web-based applications for the various stages of Geodesign, with emphasis on those where it was important to take and receive information and opinions from users.

2 METHODOLOGY

The methodology was based on the following work stages:
Representation Model - Aims to explain how the area can be described. In order to make the decision about the alternative futures considering the main variables, selecting the components that best explain the characteristics of the area, it is important to listen to the local people, and also to listen to the workshop participants. To implement this "listening" mechanism, a crowdsourcing-mapping application was developed in which people could register their points of view, georeferencing elements to be observed in the case study. Process Model – Aims to explain how the area of the case study works. Based on the opinions expressed by the actors, describing the main characteristics to be observed in the territory under analysis, the organizers could translate these impressions into technical maps that make up distribution surfaces of phenomena and occurrences. They construct thematic maps that show the reader what is happening in the territory, where and how. These thematic maps were made available to students via web platform in a WebGis application.
Evaluation Model - Aims to tell if the area of the case study is working well. Due to the access to the expressive set of information about the main characteristics of the area, users are asked to answer a web-questionnaire describing what they understood about the main components that were in WebGis. In this online questionnaire they describe each thematic system, conducting evaluations and judgments. Based on the analysis of what they described, the technical group performs the composition of the evaluation maps, which are judgments about where, in the territory, the main issues have already been resolved, where there is still a need and potentiality for interventions, and where it is inappropriate to propose changes.
Change Model – Aims to tell where and if the area can be changed. During the workshop stage, when the participants get together in front of computers, they are organized in groups of society representatives, and begin their collaborations by proposing projects and policies for the area of the case study, separated by themes (which are called "systems" of interest). It turns out that because users do not act as planners in their daily life, they often find it difficult to translate their expectations into ideas that are presented in georeferenced diagrams or polygons. The organization of ideas and the presentation of suggestions are not trivial, as those people are not planning professionals who are accustomed to translate challenges and

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difficulties into design proposals. Thus, to have the participants more prepared to present their ideas in the composition stage, which is the model of change, they were asked to answer a web-questionnaire, to register their initial suggestions to solve the needs of each system, summarized in keywords. These keywords, which are proposed to be developed for the area, were organized in a list and shared with everybody in the first stage of the workshop, helping to "break the ice" in creating project and policy diagrams.

Impact model - Aims to judge the impacts that the proposed changes can cause in the territory. In the platform used in the Geodesign workshop, GeodesignHub (Ballal, 2015), there is a data entry in the form of a combination matrix of rows and columns, which informs the level of impact of proposals from one system to another. For example, what is the impact of constructing a park in an area of industrial interest?. There are combinations that generate negative impacts, other with positive impacts, and there are still the neutral impacts. This cross analysis impacts need to be informed in the system before the workshop, so that, by dynamic cartography, while the diagrams of proposals are designed, the users can control the impacts they can produce. But deciding if a proposal can cause an impact is not trivial, and it is interesting to share this decision. In this sense, for the case study a web tool was used to apply the Delphi method, capturing the opinions of the participants in an initial round, averaging the opinions, informing the result of the averages to the participants, carrying out a second round of review of opinions, from which the final decision is reached.

Decision Model - Aims to tell what should be proposed for the study area. During the Geodesign face-to-face workshop, which takes place with the use of the GeodesignHub web-based platform, participants design projects and policies of the area, separated by systems that are the themes of interest. Then, organized into groups that represent society's interests, they choose ideas (which are the diagrams of policies and projects) among all the diagrams construct by everybody, selecting those which, in their opinion, are the most appropriate. This set of ideas composes "designs" that resemble the proposed "Master Plans". It is part of the dynamic of the Geodesign workshop to make several designs, by each team of representatives, and to create new proposals collectively, until the work reaches, by approximation and negotiation, a single final proposal. This proposal, even if it was created collectively, is the proposal of a group of society representatives, and it is necessary to verify how much the other people of the area, who were not in the workshop, would accept the plan. In order to favor this extension of discussion and decision, a web-based consultation called "voting" was applied, which captures the opinions about the diagrams per system.

3 THE WORKING STEPS DEVELOPMENT

About the working steps, the elaboration of WebGis stands out among the applications chosen to give support to each model. It made the understanding about the main characteristics of the area possible to the users, the composition of the analyses by theme and the integration of variables to create the evaluation maps. The other steps also had their importance because they acted as “listening” about values and expectations, but WebGis stands out as a way to make the participants understand how the organizers worked from the input of the base maps and combined them to construct thematic evaluation maps that were very important as reference to the design of projects and policies during the workshop meeting.

The application has the potential to bring technical information to citizens’ understanding, from the listening of expectations to the decoding of values registered by the participants. Explanations about the challenges of composing evaluation maps are a key step in Geodesign, and will be presented separately in the next topic.

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3.1 CROWDSOURCING-MAPPING

The logic of crowdsourcing is about delegating tasks to a group of people or encouraging a group of people who do not necessarily have a previous connection with the action. The principle is explained by Goodchild (2007a), who characterizes the process as "citizens as sensors" in which people collaborate with the recording of information, a process that according to Davis Jr et al. (2013) can be voluntary (when registering on a map, for example, by collaborative mapping) or passively (when their data is recorded and processed by applications, without explicitly asking the users to collaborate). The voluntary process is also known as VGI (Volunteered Geographic Information). In the specific case of crowdsourcing-mapping the goal is to make people collaborate with information, opinions and highlighting the main characteristics of an area, registering elements on a georeferenced map available on a web-based platform. Among the most popular applications that favor these collaborations are Ushahidi (that produced Crowdmap), Maptionnaire, Map Me, Story Map and ArcGis Online, among others. The collective mapping, according to Pánek and Pászto (2017), has been associated with Emotional Mapping by Nold (2009), since people record their opinions and preferences, or by Sentimental Mapping according to Caragea et al. (2014), or even Ephemeral Mapping, according to Art and Cartography Commission from ICA (2015) because they report records that are not permanent but are opinions and judgments that may change over time. This mapping is associated with feelings because in addition to recording where and what, that information can be evaluated by other users, who make comments and approve or disapprove of the element. In the case study we chose to use Crowdmap, because it is a free platform and, in the judgment of the organizers, well known. However, there was a low adherence of users regarding the interest in posting their suggestions and opinions. Some have expressed difficulties in using the application, which does not provide clearly understandable navigation. (Fig. 2). The phenomenon of low adherence to the process is already known. There is a set of scientific publications that report difficulties in having adhesion of collaborators in using crowdsourcing-mapping in general, and the experiments that work, are those encouraged by a specific project. Goodchild (2007b) explains that people only participate, motivated by self-promotion in social media, or when they may have some gain in knowledge or to reach a personal interest. Some researchers have created mechanisms for encouraging and co-opting collaborations, such as Mission-Oriented, which is a process of taking the request of participation to specific groups, according to profile or geographic location (Mateveli et al., 2015). Although collaboration has been very low, which has resulted in non-support for the characterization of the area, we still believe that in future studies it is possible to propose the same logic of using a web-based platform for citizen listening formatted in a way that favors the interface. As a consequence, it was not possible to use the results captured to define the main component variables, according to the potentialities and vulnerabilities of the area, therefore the technical group chose to study the documentation of the Municipal Structural Plan of Faenza about the territory, and from it to identify the main information that should compose the Representation Model of the case study.

3.2 WEBGIS

The use of a WebGis as a complementary application was used a lot by the participants before and after the workshop, and was a very important innovation in Geodesign, proposed in this case study and extended in others that succeeded it.

From the technological point of view, WebGIS can undoubtedly play an important role as a facilitator of communication. It stands out when it has the possibilities for three-dimensional visualization with the

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support of appropriate technologies, dissemination of information for collaboration and participation, promoting a communication not only "unidirectional", but mainly "bidirectional". This tool can certainly also be effective in different phases of the Geodesign process, especially in the steps of analyzing information and judging existing conditions. WebGIS adds the ability to share information in a distributed environment, which is useful when, as in the case study, there are different groups working on the same information base and needing to interact.

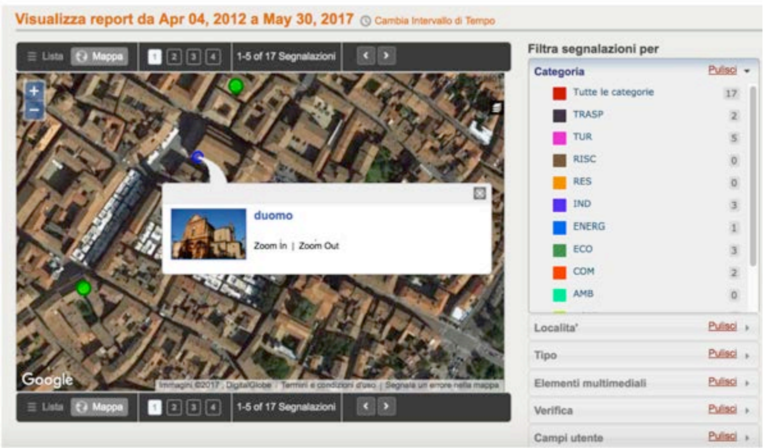

Fig. 2 Crowdsourcing to collect values and information about Faenza

In the case study of Geodesign methodology to develop proposals for the territory of the Municipality of Faenza, the data that composed a cognitive picture about the area were collected from the Municipal Structural Plan of Faenza and organized into ten main themes, from which the participants began a debate on the interpretation of existing conditions on particular aspects: environment, trade, industry, transport, public administration, and so one. (Fig. 3).

The cognitive data structure was created with the GIS and WebGIS tools, identifying ten thematic axes of information that delineate the territory conditions and presents its most relevant characteristics:

- AGRI – AGRITOUR (Agriculture and Tourism) – To plan possibilities in agritourism;
- AMB (Environmental) – Environmental interests, to protect vegetation, water resources, etc.;
- ECO (Ecology) – To face the risk of pollution in air, water, noise and the production of garbage;
- RISKS (Geotechnical Risks) – To face risks in landslides, inundation, seismic, etc.;
- TRASP (Transport) – To plan possibilities in transport like roads, cycling tracks, etc.;
- RESI (Housing) – To plan housing areas;
- COM (Commerce) – To plan commercial and services areas;
- TOUR (Tourism) – To plan cultural tourism;
- ENER (Energy) – To plan possibilities in renewable energy, like biomass, solar energy, etc.;
- IND (Industry) – To plan industrial areas and activities.

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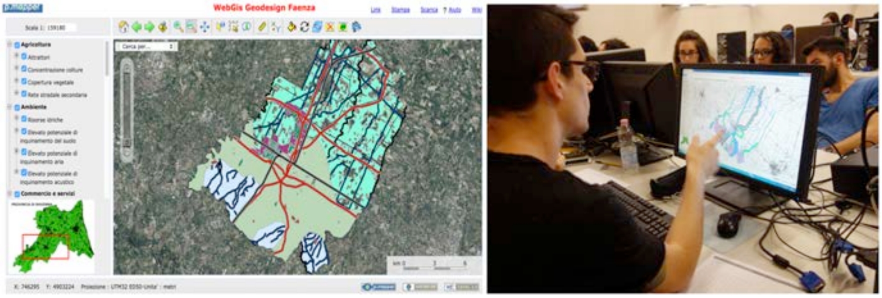

Fig. 3 WebGis to present the main characteristics of the area, organized by the main themes

The technology of WebGIS implementation chosen was that of the "server-side" type. In this case, processing takes place mainly through the server and it results in some advantages but also in disadvantages. Among the advantages, for the purposes of the case study, the facilities in programming the user interface due to the availability of packages already developed in "free code" can be mentioned, which means a reduction in implementation time. Among the disadvantages, there is the lesser capacity for interactivity of the "server-side" configuration (such as the greater difficulty to be used on mobile devices) which, however, did not create particular critical issues in the development of the Geodesign process, as most people used desktop computers.

The WebGIS created for the case study, from the point of view of information content, uses the same database developed in the GIS. The WebGIS, however, was implemented for the purpose of having the information accessible and available to the user through the web. The query interface is relatively easy to use, compared to GIS interface, although with less conditions to data management and spatial analysis, since the application allows relatively simple access, intended for users not necessarily "specialists" in technologies of geoinformation. In addition, the WebGIS environment offers more possibilities for interaction, both for possible modifications of the cartographic data and for the creation of a "cooperative" environment through the sharing of information through networks that, however, were only minimally explored in the present case study.

WebGIS has been implemented with open source software, using the following components:

- apache Web server with CGI interface (Common Gateway Interface) and PHP language for the communication between Web Server and resident software;
- mapserver as map server;
- data management environment (DBMS) Postgresql-Postgis (shared with the GIS);
- p.mapper user interface (in PHP-Javascript language). (Fig. 4).

3.3 WEB-QUESTIONNAIRE TO PERFORM LISTENING ABOUT THE VALUES

From the visualization of an expressive collection of thematic maps organized by system, in which were presented both the basic maps on the location of the main elements and also those that inform the distribution and concentration of phenomena related to the theme, users were asked to access a web-questionnaire from Google Forms. (Fig. 5).

In this questionnaire, answered online, they should write a paragraph describing what they understood about each system: what were the main characteristics, potentialities, vulnerabilities. From this brief

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description it is possible to capture the collection of understandings, and from there arise the descriptions of the essences that characterize each system in the case study.

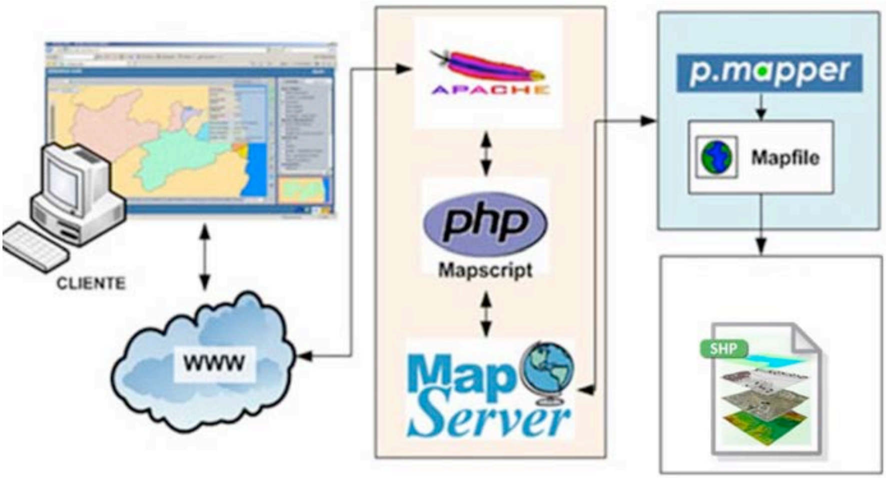

Fig. 4 The structure of the WebGis

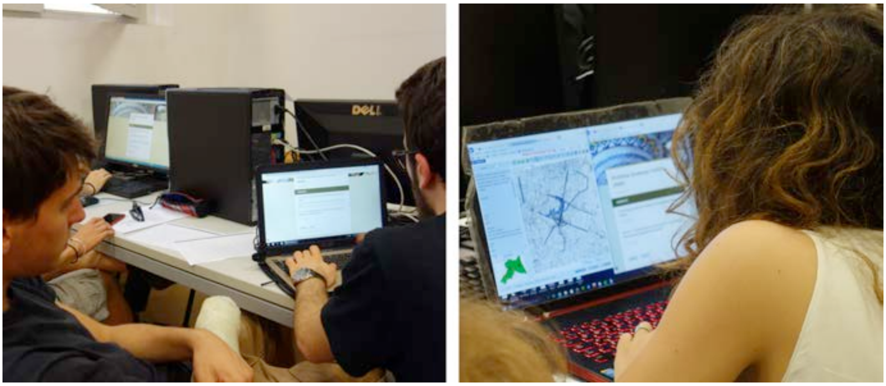

Fig. 5 The Web-questionnaire in order to understand the main values

The organizers then collected all texts, from all users, by system, and made a summation in a text file, which was visualized in a cloud of words. Word-Cloud is a digital graphic that shows the frequency of words in a text. The more the word is used, the more striking the representation is of that word in the graph. (Fig. 6). As a result, it was possible to highlight what people think as main values and demands for each system or theme, and this was a support for the construction of evaluation maps, which are judgments about where it is possible and where it is necessary to make proposals for changes in the landscape.

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3.4 WEB-QUESTIONNAIRE TO COLLECT SUGGESTIONS AND IDEAS

In the same application where the user was asked to interpret the system, a request was also made to suggest ideas to solve the main problems and to meet the main demands and potentialities by theme. Using also Google Forms, the user was asked to write up to five keywords per system, with ideas to be developed for the territory.

The goal was to create a set of initial ideas that could be developed in the form of georeferenced diagrams as soon as the workshop started. The reason for asking them to think about the possibilities is justified by the need to put the participants to think about issues that would be discussed at the meeting and to activate their minds to build ideas. This would reduce the initial difficulty of proposal composition and would already indicate trends and values to be pursued in the workshop.

Fig. 6 The Word-Cloud with the main ideas about the area, by topic

Upon arriving at the face-to-face workshop, users were able to see on the blackboard the entire list of all the ideas already indicated, per system, and as new ideas emerged, they were included in the cast. This list could also be distributed by a document shared on the web and projected onto a screen, but it was quite dynamic to have the relationship visibly placed on the blackboard. (Fig. 7). Adding to the list of ideas to be developed, the GeodesignHub developer, Hrishi Ballal, introduced the functionality of adding hashtags to the diagram drawings, so that it would be possible to search for keywords and identify if another user had already proposed something similar to what was under planning. Notwithstanding that similar new ideas could also be designed, but it was a way of identifying common expectations that could be used as strategies of negotiation and consensus.

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Fig. 7 The Web-questionnaire to get ideas to be developed, in keywords. Blackboard with the keywords per system

3.5 WEB-BASED DELPHI CONSULTATION

The GeodesignHub platform is programmed to receive an indication of values in a system combination matrix, in which it is defined what the possible impacts will be of a project or policy proposed to a specific theme in positions that would also be of interest to other themes. But this decision is not trivial, and it is common for participants to have divergent opinions on these judgments, ranging from the most positive to the most negative, going through the neutral. (Fig. 8).

Fig. 8 The systems combination matrix

To have the opinion from the participants about how a proposal planned to one system could disturb the other interests positively or negatively, they were asked to give their opinion on the composition of the final decision on what the impacts of the proposals would be. To collect the opinions, the Delphi method was used to construct consensus.

The Delphi method was first proposed in the 1950s by the US military, the Research and Development (RAND), with the goal of dividing responsibilities and arriving at the best solution that would be a consensus among those participants involved. The name comes from the Delphi Oracle, because the goal is to support decision making. The argument is that group judgments are closer to reality and more accurate than

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individual judgments. According to Dalkey and Helmer (1963) the method is composed of questionnaires applied in rounds to experts or invited participants, and these rounds are interspersed with feedback, aiming at the convergence of participants' opinions. Although some authors, such as Linstone and Turoff (2002) argue that the number of rounds should be as many as necessary until convergence of opinions is reached, we believe that absolute consensus does not exist, and what can be done is searching for maximized consensus, which led us to opt for the use of two rounds.

In the case study, the SurveyMonkey platform was used, which is not free-access, but it could also be possible to use a Google Form to do something similar. The users were asked to judge the combinations between systems as -2 (most negative), -1 (negative), 0 (neutral), +1 (positive), and +2 (more positive). We asked the participants to keep the notes about their first opinion. The average of all opinions was calculated, per combination, and the result was presented so that the participant could compare the opinion of the majority with his own opinion, and he had the right to make adjustments, if he wanted. A new final average was calculated, and GeodesighHub was settled with these values. (Fig. 9).

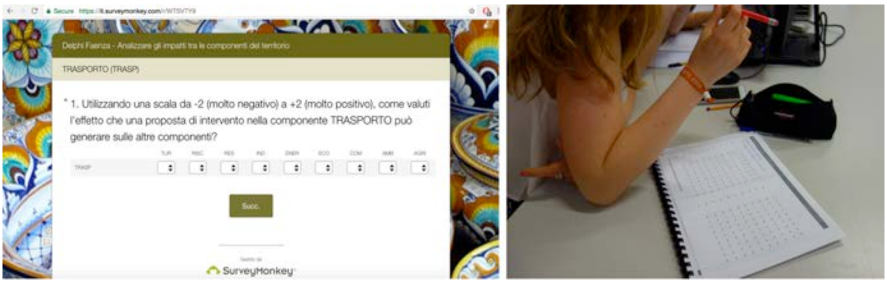

Fig. 9 Delphi web-based. The two rounds of opinions

3.6 THE WEB VOTING SYSTEM FOR THE FINAL DECISION

Since face-to-face meetings in Geodesign workshops can only receive a limited number of participants, chosen as representatives of the society, it is important that the proposals built by this group are evaluated and validated by a larger number of people. In this sense, the programmer of GeodesignHub, Ballal, created a voting mechanism in which, through a link, those interested can access the results of the workshop and evaluate, by system and diagram, if they are in agreement with the idea, indicating "approved" or "not approved". Being aware that web-based opinion queries should be fairly streamlined and brief, the user sees each diagram at a time to vote. They appear in the form of diagrams with their names and descriptions, overlapping good resolution satellite images. To publicize the possibility of voting we used social media to send the link. In the case study we opted for Facebook, through paid promotion per day, targeted at users who were located in a territorial delimitation, defined by the area of influence of Faenza. Thus, during a period of one week, people located in the Faenza region received the advertisement of the vote on Facebook and were able to participate voting and including comments on the platform. (Fig. 10).

More research is needed on the role and quality of this type of consultation, since there are phenomena of participation in social media that are already being studied as limiters or challenges to be considered in the consultations.

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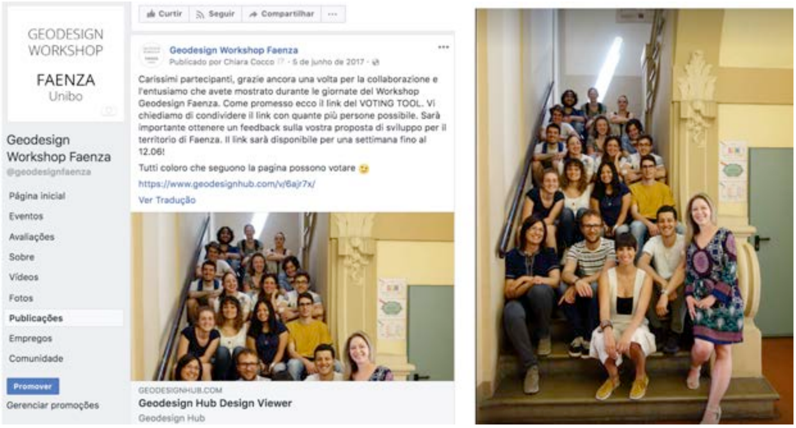

Fig. 10 The advertisement to take part and the voting process

4 THE PRODUCTION OF EVALUATION MAPS AS A SUPPORT FOR THE CO-CREATION OF IDEAS

The use of web-based applications, as described in the previous item, was extremely important to get opinions about citizens' values and expectations, to broaden the participants' understanding about the area, to involve participants in different stages of judgment of values, and to give support to the proposition of ideas and construction of agreements. However, there is a stage that is under the responsibility of the technical staff and that can be favored by this listening to the citizens, who can act more safely while contemplating both expert knowledge and the opinions of people of the place.

By listening to the main values and what should be observed better in each system, the technicians can contribute with their knowledge and responsibilities in indicating restrictions and possibilities, but can also consider characteristics that are values for the local community. This is done through the technical elaboration of the evaluation maps, which are the references from which the participants of the Geodesign workshop build their ideas. (Fig. 11).

In the preparation of the evaluation maps, the technician must be aware of the need to combine variables, which are the main components indicated by him due to his knowledge and also by the local people as their opinion about what is important for characterization of the territory, by theme or system. Combinations can happen by multi-criteria analysis based on weighted sum or combinatorial analysis to identify territorial coincidences.

The multi-criteria analysis by weight of evidence, which uses weighted sum algebra, aims to generate an index, classifying the area from the lowest to the highest potential for some activity or proposal. Combinatorial analysis identifies all possible combinations of occurrences, without the risk of making the initial information disappear, being possible to highlighting some element that must remain significant apart from the other layers of information.

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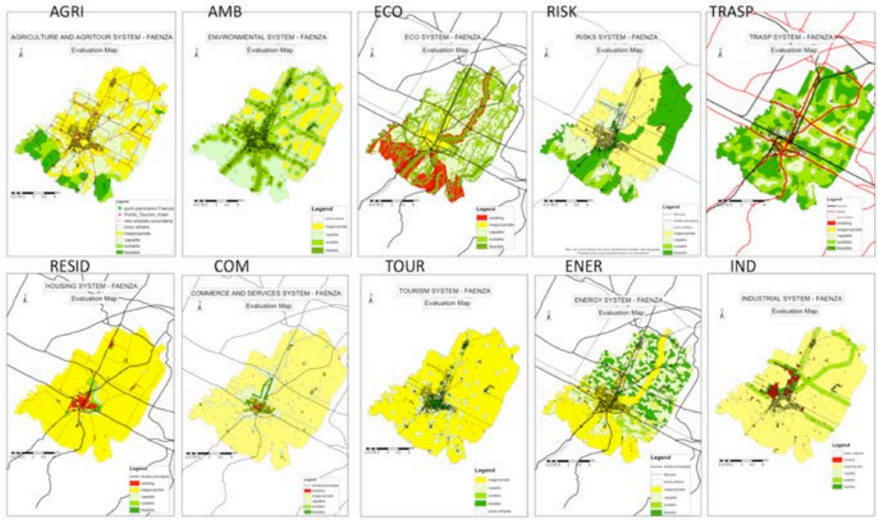

Fig. 11 Collection of Evaluation Maps – case study of Faenza

In the following example, it should be noted that in the case of multicriteria analysis based on weighted sum, an index is created and the specific presence of each component is no longer identified. In the case of combinatorial analysis, the presence of each occurrence is still recorded, being possible to identify some element that must remain highlighted. (Fig. 12).

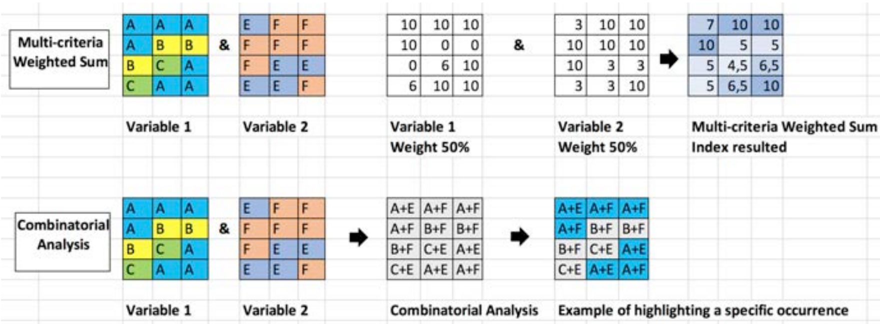

Fig. 12 Multi-criteria Analysis and Combinatorial Analysis

4.1 EXAMPLE OF THE COMPOSITION OF THE EVALUATION MAP USING MULTI-CRITERIA WEIGHTED SUM

In the analysis of multi-criteria it is necessary to define the main variables that will compose an index of potential for some transformation. In the illustrated example, the variables selected to analyze areas indicated for environmental recovery. They were about water resources, fragilities due to the use of chemical products and the generation of waste, fragilities related to noise pollution and fragilities related to

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air pollution. The variables were combined by similar weight and resulted in a map that is an index of interest to environmental recovery intervention, to propose projects or policies for this system. (Fig. 13).

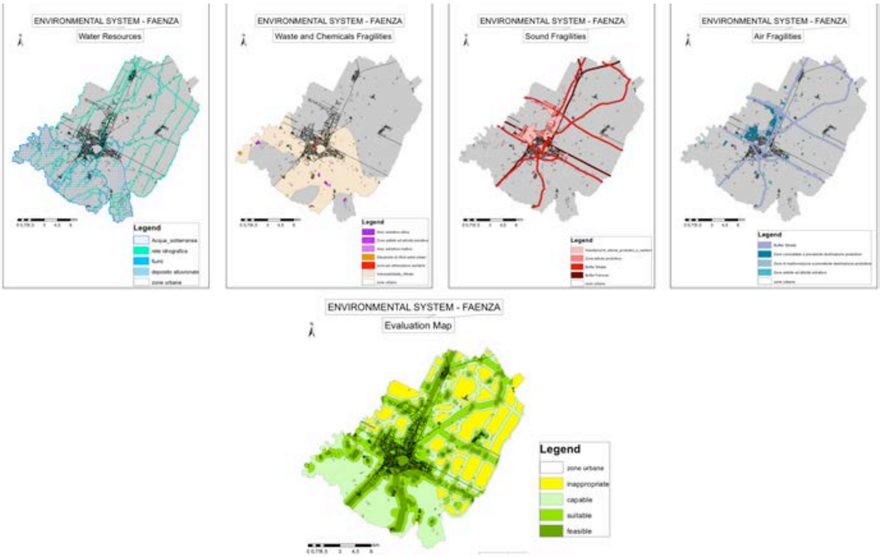

Fig. 13 Multi-criteria Weighted Sum to compose and index of priorities to propose projects or policies to face environmental fragilities

4.2 EXAMPLE OF THE COMPOSITION OF THE EVALUATION MAP USING COMBINATORIAL ANALYSIS

In the combinatorial analysis it is also necessary to define the main variables that will compose a synthesis map that highlights the most important occurrences to be considered as reference for the proposition of projects and policies of a theme. In the selected example the objective was to construct a risk map, indicating all the places where there was some risk, so that solutions could be proposed.

If multi-criteria analysis were employed, a lot of information could be lost because the weighted average would highlight only those areas where all or most of the risks appeared. In combinatorial analysis, what was important in each map is maintained and appears in the final map as a priority area of intervention. (Fig. 14).

5 RESULTS AND DISCUSSION

The work presents itself as a contribution to the study of Geodesign, in which the objective is the co-creation of alternative futures for a territory. It was developed in an academic environment, with the objective of testing the effectiveness of web-based applications in all stages of the process, initially with the generation of digital natives, but the broader objective would be to create references so that the processes could also be used in other workshops.

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From the point of view of the tests with the participants of generation Y, it was verified that, as digital natives, they had no difficulty in using the web-based platforms and the applications proposed, and the fact that we opted for these media favored that they remained interested and very active throughout the whole process.

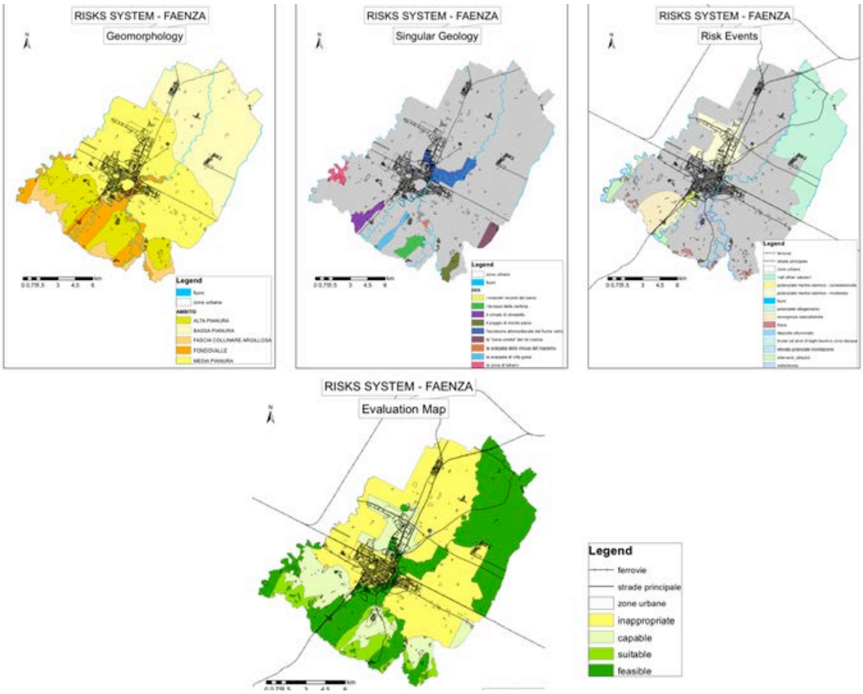

Fig. 14 Combinatorial Analysis to compose the spatial occurrence of elements and to highlight the most important ones to be considered. The risks to be faced are in the example

From the teaching point of view, the restricted number of course hours were sufficient for the learning process to take place, and for them to do the experiment with a robust and reproducible method they can use in other case studies in the future. The fact that we chose a real case study, with real data and a known territory favored the learning process and the interest.

Based on our experience, we started to use web-based applications in all other case studies developed in all stages of the Geodesign framework, in the pre-workshop phases, during and after the workshop, in propositional and evaluation steps. In traditional use of Geodesign, organizers perform various tasks before, during and after the workshop, in the following scheme (Fig. 15):

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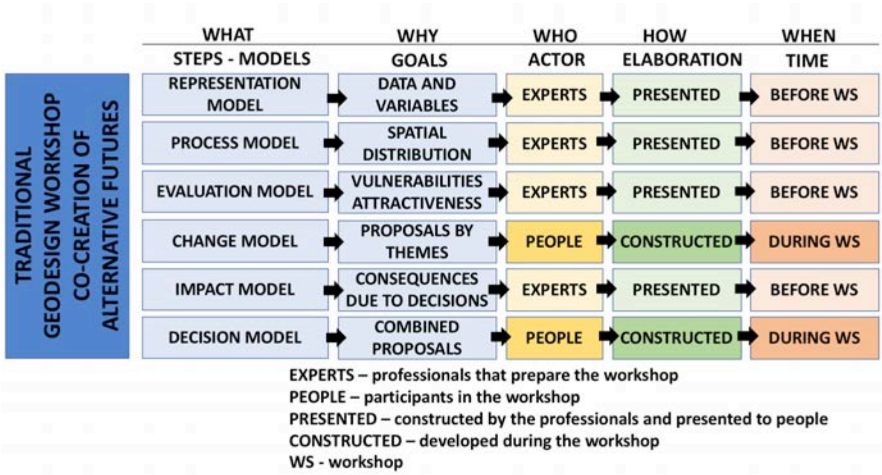

Fig. 15 Traditional scheme used in a Geodesign workshop, following the framework of Steinitz (2012). Activities according to the objectives, the people involved, the way and the moment they are presented or constructed by the participants or the organizers

To foster better understanding and involvement of participants, we proposed the use of web-based applications in all the steps of the framework. We present when, the goal to be achieved, who is going to use the application, if the results are going to be presented to the participants or if they are going to be constructed by them, and when the applications are going to be used according to the steps of the Geodesign experiment. The proposal follows the following scheme (Fig. 16):

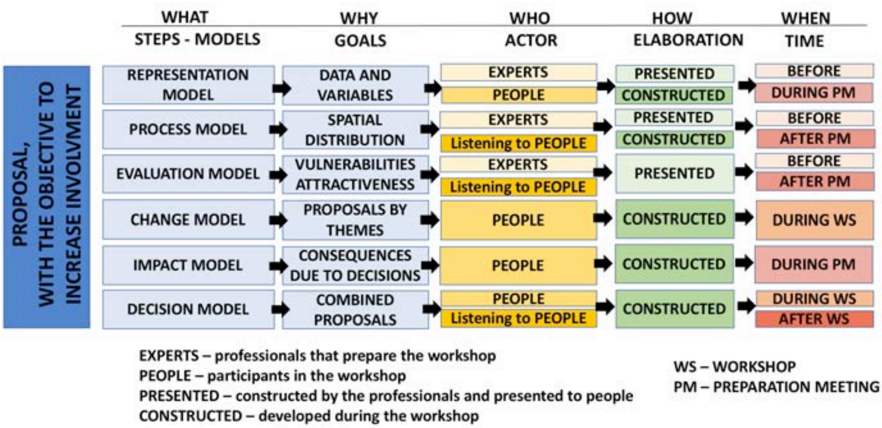

Fig. 16 Proposed scheme including web-based applications to foster better understanding and involvement of participants by broadening co-creating ideas. Activities according to the objectives, the people involved, the way and the moment they are presented or constructed by the participants or the organizers

According to each model, some web-based applications are proposed, and there are tasks to be done by the experts that organize the Geodesign experience, and tasks to be developed by the participants. The goal, in

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the models of representation, process and evaluation is to identify the genius loci of the place, to highlight the main characteristics of each system using cloud-words and to produce evaluation maps that represents the main expectations and values to be considered, for each system. (Fig. 17).

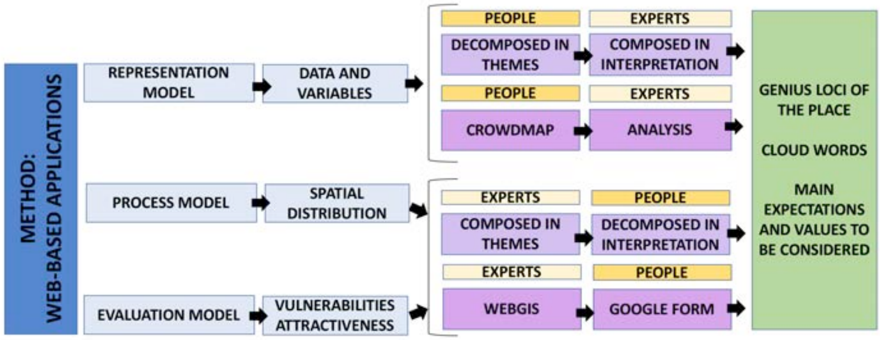

Fig. 17 Proposed scheme including web-based applications to foster better understanding and involvement of participants by broadening co-creating ideas. Geodesign framework activities steps and intentions or possibilities of using applications. Registration of actions by participants and by organizers, and results to be obtained. Stages of representation, process and evaluation

In addition to the stages of change, impact and decision models, there are tasks to be done by the expert technicians who organize the Geodesign experience and tasks to be developed by the participants. The web-based applications result in support for the construction of ideas to be proposed, in the classification of the probable impacts to be caused in each system from the proposals made, in the support to the co-creation of project ideas and policies for the area, and in the expanded vote on the acceptance of the proposals made. (Fig. 18).

The interest to get participants involved in all the steps of the preparing of the workshop has the goal to make them understand better what and why they are doing some tasks. While informing about the main characteristics of the place, promoting discussion about vulnerabilities and attractiveness, the applications and also educating people to analyze data, transforming them into information and with the possibility of constructing knowledge. People learn about the place, from the technical point of view, and also about how to read and interpret spatial data. The experiment a process of co-creation of ideas.

From the technical point of view, the organizers learn from people of the place about their values and expectations. They can decode collective values and transform them in designs that fits the people and the place. They have to do efforts to present information in accessible language, to create a dialogue with all the participants of the process. The more the invest on visualization tools, the better participants will be able to contribute in the co-design. The more they invest on web-based tools, the bigger the number of people that will be able to take part, and design thinking will be part of society, co-creating the common future of a group.

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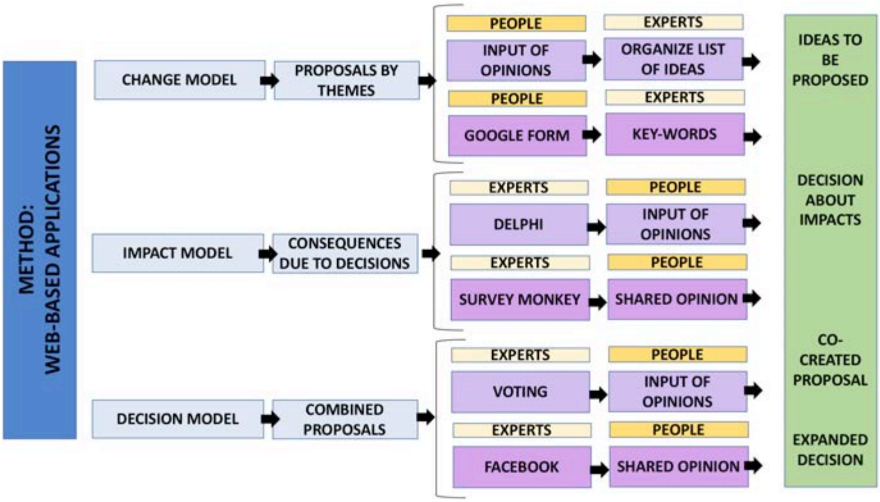

Fig. 18 Proposed scheme including web-based applications to foster better understanding and involvement of participants by broadening co-creating ideas. Geodesign framework activities steps and the intentions or possibilities of using applications. Definitions for the actions to be made by the participants and by the organizers, and expected results to be obtained. Stages about change, impact and decision models

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COLLABORATIVE APPROACH IN STRATEGIC DEVELOPMENT PLANNING FOR SMALL MUNICIPALITIES

APPLYING GEODESIGN METHODOLOGY AND TOOLS FOR A NEW MUNICIPAL STRATEGY IN SCANZANO JONICO

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ABSTRACT

Facing urban development in weakest Italian municipalities is a critical technical activity which requires an integrated and inclusive approach for strategic goal selection together with effective monitoring tools describing local trends (concerning economy, services, employment, etc.) and local communities' needs. The case study of Scanzano Jonico in Basilicata represents an interesting strategic planning laboratory due to the fact that the municipality is characterized by sensible territorial resources (mainly un-exploited), a developed agricultural system, a weak urban structure characterized by a generalized lack of effective public service, insufficient infrastructures. In a perspective of concrete and feasible strategic development planning, based on the lack of public resources and facing the challenge to guarantee better living conditions for local communities, the operative methodological framework of GEODESIGN was applied. A bottom up workshop oriented to identify a shared development scenario was performed including local relevant stakeholders. The paper presents territorial analyses represented in "systems" of suitability maps according with Geodesign Approach; then the results from the workshop are discussed in order to assess strengths and weaknesses of the application.
The strategic design obtained through the participative workshop is characterized by a strict link with territorial features and local community ambitions and represents a "context-based" scenario suitable to implement regional cohesion policy main objectives.

KEYWORDS
Strategic Planning; Geodesign; Partecipative Workshop

1 INTRODUCTION

To face urban development in weakest Italian municipalities, is a critical technical activity which requires an integrated and inclusive approach for strategic goal selection together with effective monitoring tools describing local trends (concerning economy, services, employment etc.) and local communities' needs.

Among recent approaches, "Tactical Urbanism" may be considered an innovative approach in urban planning, mainly oriented to urban regeneration. It includes quick, often temporary, cheap projects that aim to make a small part of a city more livable: "short term action for a long long term change" (Lydon et al., 2015). Tactical urbanism actions are often promoted by social groups acting at local level, who are moved by the awareness that current planning tools are no longer effective to meet the immediate needs of communities. We can affirm that Geodesign methodology (Steinitz, 2012; Steinitz et al., 2017) represents an effective methodological background in promoting innovations: bottom up and participatory planning (Campagna et al, 2016; Rivero et al., 2015). In fact it foresees a close collaboration between technicians, geographic sciences, information technology and "local people", decision makers in order to propose shared solutions (or/and strategies) for urban and territorial development. Steinitz defines Geodesign as "meta-planning": an explicit design of the planning process. According with Campagna (2016) meta-planning, at the same time, can support the construction of the framework for the territorial design and it also contribute to the development of IT systems supporting planning process according to the Geodesign approach. We consider such view coherent with a wider definition of planning: an advanced form of social agreement oriented to preserve public interests (Las Casas, 1995; Las Casas et al., 2017; Las Casas et al., 2018) and, under an operational dimension we include Geodesign in the sustainable planning toolkit (Las Casas et al., 2009; Las Casas et al., 2016).

In a perspective of concrete and feasible strategic development planning in weak municipalities, where the on the lack of public resources represents a precondition for any strategic proposal, the operative methodological framework of GEODESIGN was applied in order to define challenging scenarios oriented to guarantee better living conditions for local communities (Campagna et al., 2014; Moura et al., 2016; Nyerges et al., 2016). This work presents the results achieved through a Geodesign workshop in Scanzano Jonico, a small municipality of Basilicata Region (Italy), located along the Ionian cost.

It should be noted that this work contributes to a wider research, the Geodesign International Collaboration, a worldwide research network promoting experimentations of Geodesign method in local case studies founded by C. Steiniz.

2 THE CASE STUDY OF SCANZANO JONICO

The case study area represents an interesting strategic planning laboratory due to the fact that the municipality is characterized by: sensible territorial resources (mainly un-exploited) including natural and cultural heritage sites; a strongly developed agricultural system, a weak urban structure characterized by a generalized lack of effective public service; un-effective stock of mobility infrastructures. Moreover Scanzano Jonico Municipality is an emblematic case representative of the wide number of small municipalities settles in peripheral and marginal territorial contexts, expressing critical socio-economic development demand.

Scanzano is a coastal town in southern Italy, characterized by sandy coasts near which extends a pine forest declared protected areas under 92/43/CEE "Habitat" EU directive as to the Sites of Community Importance. In addition to the significant natural heritage, the municipality only includes a few buildings and places that

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can be an expression of a sense of identity. They are: the Baronial Palace, the Aragonese tower rising close to the sea, the Recoleta farmstead and the archaeological site of Termitito. However, all these resources are not well exploited due to the lack of an integrated territorial promotion strategy and consequently they are poorly valued and actualy rest in a state of decay.

A large part of the territory is constituted by the agricultural system that represents the driving sector of the local economy. Among agricultural products, the "candonga" (a strawberry variety) is renowned at national and international level. Even if agriculture is predominant, the sector suffers relevant problems such as the progressive fragmentation of land property and the consequently reduction of income for small farmers. Additional criticalities regard and the unproductivity of some areas due to soil salinization and desertification processes.

The urban structure is very weak in correlation to the ineffective public service supply. Main critical issues regard: inefficient public lighting, waste emergencies, the isolation of some suburbs of the municipality strongly disconnected from the main urban center, stray dogs, lack of infrastructures for local public transport. These problems show a degraded and highly inhomogeneous urban context.

The inadequate public services produced widespread social degradation resulting in an increase in crime, depopulation of rural areas and migration especially of the younger population as there are no adequate job opportunities.

There are worrying shortages for logistics and urban transport, especially in the connections between the urban center and the rural units belonging to the municipality (namely: Recoleta, Terzo Cavone, Terzo Marzocco, Andriace) as well as the coastal part of the territory, the main tourist attracting area of the municipality.

From the synthetic information described so far it is clear that in order to start an effective process of strategic development based on territorial specialization, an inclusive approach based on participation and targeted planning is relevant in order to deliver suitable scenario based on a (in)formal agreement among local actors.

3 THE GEODESIGN WORKSHOP IN SCANZANO JONICO

The most important part of the case study was the Geodesign Workshop held the municipal house of Scanzano Jonico on 25th and 26th June 2018. The workshop was attended by: a significant representation of the municipal administration (Mayor, Deputy Mayor and Councilor for Culture), the president and vice-president of the UNI3 association, the technicians of the municipal office and two university students.

The identification of the actors was based on LFA methodology. Potential stakeholder was compared with the others in terms of "Influence Capacity" (concerning decision making process) and "Commitment" in the implementation of the proposals. They have also been divided into three categories: Institutions, Organized Groups and Informal Groups. Then, depending on interest and influence, some representatives were chosen as spokesperson of several parties. For example, for the associations the president and vice president of UNITRE were chosen. In this way multiple interest were represented inside the workshop participants. In the same way, the Councilor for culture as well as the tourism entrepreneur and the Councilor of the Minority Party and agricultural entrepreneur of the municipality of Scanzano Jonico were chosen. Concerning the citizens' group, instead, two local students were invited to participate.

The workshop took place in 2 days. During the first day, the importance of participatory planning was explained using the advantages of the Geodesign framework methodology. We shared with participants the key points of the methodology and main findings of the context analysis (the Systems).

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Before approaching the "Geodesign Hub" platform, we asked them to draft intervention proposals (the Diagrams) on printed paper evaluation maps. Afterwards each participant was asked to report the respective proposals within the platform. Those two steps allowed to reconsider first hypothesis drafted on paper when each participants used the platform to draw the final diagram according Geodesign Method.

On the second day two "change teams" were settled-up. The "change team" represent a way to overcome the individual approach in proposing projects and intervention toward the development of a collective vision of strategic scenario based on the selection of available project proposals.

According with workshop results and participants characteristics, two groups were identified: separating the members of the administration and all the other participants.

Each group discussed the proposed interventions by selecting the best ones. Then the choices of both groups were compared. The results could be considered quite compatible according with the following diagram comparing decision model.

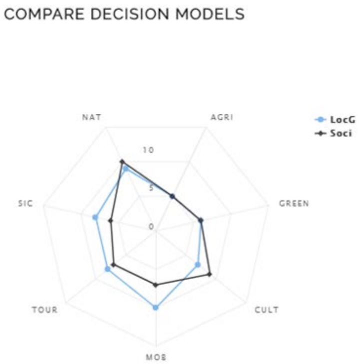

Fig.1 Decision Model defined by the two change team

After that the negotiation phase began. During this final stage the groups discussed and evaluated the two proposed development scenarios in order to reach "one" shared vision of intervention strategy.

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Fig.2 Workshop participants during individual design phase

4 SELECTED INTERVENTION DOMAINS AND RESULTS

According with Geodesign Methodology the context based assessment for the strategic decision making and negotiation process was organized in a number of “Systems”. Each System represents an intervention domain and was identified according to a technical interpretation of local characteristics. The final result of such technical interpretation was presented to the workshop participants in term of Land Suitability assessment. It is a way allowing an effective communication of technical concepts and results also to common people without specific background in urban planning. The selected intervention systems for Scanzano Jonico case study were: Security; Culture; Mobility infrastructures; Tourism; Green areas; Environment and ecosystems; Agri-food. The first 3 systems represent the elements of vulnerability of the municipal area while the remaining elements represents the main components generating territorial attractiveness.

Fig.3 7 Systems for Scanzano Jonico Geodesign

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From the preliminary discussion of the 7 Systems, through the individual identification of desired intervention projects and policies, all the participants delivered a final negotiation map: it represents the shared intervention scenario. The analysis of the results obtained shows that the development of the agri-food system and the related strengthening of rural tourism are not among the priorities of any of the established groups. The majority of the interventions concern the tourism system for which a policy of valorization is envisaged with targeted interventions to recover the most attractive areas of the territory, such as: restructuring the equipped dune, creating an archeopark in the area of Termitito archaeological excavations, pursuit of the "green flag" project. Interventions on the infrastructural mobility system have been concentrated on the rebuilding and maintenance of those roads connecting the potential historical-cultural attractions of the municipality (the Recoleta farmstead and the archaeological excavations) as well as the arteries connecting the beaches. On the other hand, cultural system was mainly considered in terms of redevelopment of historical-architectural elements such as the Aragonese tower and the Federici Palace in the Recoleta area. As far as the security system is concerned, the interventions mostly regard the installation of an urban video surveillance system in those areas where, in the last year, crime phenomena were concentrated and in the areas most frequented by children and young people. To improve the efficiency of urban video surveillance, an intervention policy has been proposed for public lighting in the inhabited center and in correspondence with tourist facilities. The proposals concerning the "environment and ecosystems" focused on the stabilization of the banks of the Agri and Cavone rivers by means of gabions (to limit the risk of flooding) and the conversion of the hydrovera with purifier, as well as the adhesion to the RENDIS project "National Repertory of interventions for the defense of soil "(http://www.rendis.isprambiente.it/rendisweb). Finally, for green areas, it was decided to recover those disused green urban areas and to apply a recovery policy for the SIC areas that are currently not exploited.

Fig. 4 La mappa finale di negoziazione

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5 FINAL REMARKS

The present work was conducted in order to test the Geodesign methodology for the evaluation of strategic development scenarios through a participatory approach and the involvement of the local community and a multiplicity of stakeholders. Scientific literature highlights the role that this methodology can play in current spatial planning practice featured by a meaningful complexity mainly linked to the multi-dimensional context characterizing its processes (Cocco et al., 2018). It has been demonstrated how the use of Geodesign is well suited to be applied to tackle complex problems involving a multitude of actors of different backgrounds and to supports complex processes encouraging shared conception and choice of scenarios of sustainable future development scenarios (Campagna, 2014; Campagna et al., 2018; Di Cesare et al., 2018). Participation represent a way to improve and to realize inclusive planning approach, that has been mentioned many times, also in the context of commitments by the international community (UN HABITAT 2015, 2016, 2017). In fact we may affirm that it is mainly relevant in terms of problem identification: people can highlight criticalities and priorities that are not included in the technical territorial assessment (Ballal, 2015; Moura et al., 2018). The urban community represents a resource for the planning for the "future-city" as it provides "alternative" visions of the problems and objectives to realize an effective context-based strategic planning. In the case study we synthetically discussed in this paper, the actors have in fact provided a creative contribution in proposing interventions during the workshop. The intensity of their participation was variable (depending on the commitment level of each actor). The case study of Scanzano Jonico, then, shows how the use of Geodesign as a participatory planning methodology represents an useful tool to tackle complex problems on municipal scale, involving a multitude of actors from different backgrounds. Although GEODESIGN cannot be the only methodological support for the implementation of the principles of sustainability of urban development, it can certainly contribute to a substantial renewal of the tools of the planning discipline that is now facing new challenges and problems.

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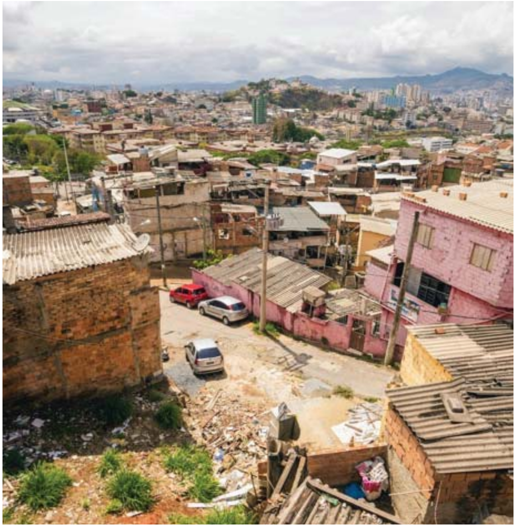

THE APPLICATION OF GEODESIGN IN A BRAZILIAN ILLEGAL SETTLEMENT

PARTICIPATORY PLANNING IN DANDARA OCCUPATION CASE STUDY

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ABSTRACT

The paper discusses the results of the application of Geodesign framework proposed by Steinitz (2012) in a case study of an informal settlement in Belo Horizonte, capital of Minas Gerais, Brazil. The local plans that promote illegal settlements urbanization were proved inefficient in terms of time required to produce results and limited involvement of locals. In order to find an alternative planning strategy, the municipality decided to test the Geodesign method, due to its interdisciplinary structure combining design technologies, geographic information system and shared common language and visualization tools to engage stakeholders. The workshop considered all the stakeholders involved in the case and produced a co-created project, where all the actors participated actively. Dandara occupation is considered one of the biggest planned illegal settlements in Brazil, but the people are still living in precarious conditions. After only two days of intense workshop, an agreement has been reached: the plan appeared more simplified, responding to the real needs of Dandara people in accordance with the local rules. The next step, that is the main focus, is to promote another Geodesign workshop, now involving Millennial in a workshop for the same scenario. The main goal is to test the methodology and the tools with different participants and compare the results of academic workshop with the real one that had involved the residents. Can the Millennial understand properly the problems of the area and produce coherent proposals for this reality? What is the role of web-based technologies to support decision making in informal settlement issues?

KEYWORDS

Geodesign; Participatory Urban Planning Informal Settlements; Geotechnologies

1 INTRODUCTION

Brazil can be regarded as an urban country since the 84.3% of the Brazilian population is concentrated in urban areas that represent only the 1% of the whole territory (Farias et al., 2017). That explains why nowadays the majority of Brazilian problems are linked with urban contexts, where the right of housing is the most important issue in this debate. Housing deficit - that measures the shortage compared with the totality of houses in a area - in Brazil is constantly worsening: as shown by the data, it moved from 9% in 2014 to 9,3% in 2015 (Pinheiro, 2018). So it's clear that housing and city access are not already rights for everybody. That is reflected in a uncontrolled and segregating urbanization.

Belo Horizonte original urban planned was following the modernist models of that architecture that revealed, right from the beginning, its weakness that resulted in the first informal settlements. This phenomenon reflects the lack of facility to access to the formal city. Since the 1970s, with a major boost to the industrialization, a big social and demographic transformation occured in Minas Gerais State bringing an intense urban densification (Monte-Mor et al., 1994).

"Favelization" process was a consequence of these events and further exacerbated by the inappropriate low-income housing policy, a strong interference of the private enterprise sector in the social housing market and a general rising in land prices.

Although, from the 1970s until today, the housing policies have taken some steps forward, the situation is not really improved: the housing deficit in the RMBH (Metropolitan area of Belo Horizonte) increased of 53883 from 2011 to 2014 (FJP, 2018). Consequently, irregular settlements in urban areas represent an alternative and solution to such denial of right. The paper's case study is part of this context. *Dandara* informal settlement was created in 2009 in the prime district of Pampulha in the North region of RMBH. It's considered the largest organized and planned occupation in Brazil supported by various sectors of society (Soares, 2013) but they are still waiting for the urban and juridical regularization. Nowadays the legal instrument for irregular settlements urbanization is the Global Specific Plane (PGE), which sets out the development guidelines and defines the hierarchy of the interventions to be implemented. It became mandatory, since the 1990s, for that *vilas* and *favelas* which had earned the Participatory Funding (OP) and the necessary financial resources for the PGE implementation (Conti, 2004).

The ones with the powerful and organized political leadership could be more successful in obtain this right: that was *Dandara's* case, although it was considered a young settlement. The PGE instrument represented an historical turning point in this matters but it has represented some failure in the applicative and methodological aspects. According to Conti (2004) the PGE's weak points are: lacking of feedback among the steps of the process, shared agreement between the actors but unfulfilled at the end, superficial knowledge of these issues, inflexible methodology that cause rise in prices, high people expectations and the difficulty of implementation caused by administrative and technical obstacles. These facts produce tensions between public powers and users, and scepticism among the communities about new proposals. Consequently there is the need of a new urban planning methods and more participatory approaches, fast and so cheaper and efficient. Geodesign methodology aims to developing planning solution that could be applied to different scales. Steinitz's (2012) framework is based on six models from the conceptual analysis to the design creations itself, simulation and impact assessment, with the Geographic Information System (GIS) support.

At the end of 2017, a team of the Geoprocessing Laboratory of UFMG was invited by the Municipality of Belo Horizonte (PBH) to realize the first Geodesign workshop involving *Dandara* residents to produce an Urban

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Regularization Plan (PRU) (De Paula et al., 2017). The PBH had already tested this framework to another illegal settlement case, the *Maria Tereza* occupation (Zyngier et al., 2017), but the *Dandara* case has been the first application involving the people of the place to create a real upgrading project to be implemented. Residents, technicians and professionals participated to PRU's proposal through a collaborative planning, aim to obtain a coherent program with the local expectations.

This was a very new approach for the municipal plan way because for the first time included actively the population, increasing dynamism and fluency of the procedure. All this ingredients could reduce the risk of the obsolescence of the proposed plan, as this is one of the main problems for these informal areas affected by rapid changes. The residents participated in the production of proposals along the decision-making process, from the analyses to the final shared plan.

This will attend all participant needs and make the Municipality able to play its role of democratic director of the city, respecting what is stated in the City Statue (Federal Law 10.257/2001[1]). The PRU has reached a final agreement after only five months from the workshop (March 2018) demonstrating the rapidity and efficacy of the methodology in conflict's resolution in urban regularization cases.

This paper discusses another workshop applied to *Dandara* case in April 2018, but in this case was an academic experiment involving *Millennial* - young born between 1980 and 1994 - totally from the architecture and urbanism field of study.

2 OBJECTIVE

The main objective of this experiment was to test again the application of Geodesign methodology as a participatory planning process in a social interest area. These areas are poor in basic infrastructure and fragile in social situations, so a different planning and monitoring approach are necessary. This makes this application really unique comparing with other Geodesign workshop already done that involved the formal city. The methodology rapidity could directly economize financial resources and indirectly reduce conflicts between the stakeholders, differently affected by the changes, and join them working towards a common goal. The second aim was to test the Millennial ability to understand the potentiality and vulnerability of the area using the web-based technologies.

These tools simplify the comprehension of the area and catalyze the participants' interaction promoting interoperability between the actors. So it was possible to deduce the participants' differences in terms of interaction with these platforms. The more interesting contribute was the variation of results between the young students and the occupation residents. Finally the other objective was to compare the results of this new workshop with the other one that involved the people of the place analyzing the quality of the proposals and the Millennial involvement and evaluating their creativity and innovation level. So could be possible to infer which condition and aspect influenced each project: are the cultural and social differences between the participants, their academic background and/or the insufficient knowledge offered before the workshop? It was possible to deduce it thanks to the critical posture of the technicians during the experiment and further with the final feedbacks from participants. The results of this application won't be applied in the real context because the presence of the people directly affected by the changes is indispensable.

[1] Senado Federal, Law n° 10.257, July 2001. Estatuto da Cidade – Brasília, DF.

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However this academic experiment has been helpful to understand the efficacy of the tools and the difficulties faced along the process, as well as the approach of Brazilian young architects in these conflicting scenarios.

3 GEODESIGN FRAMEWORK

The Geodesign concept has been worked and improved exponentially in recent years, but the origin of this concept is not new. For the creator of the Geodesign Framework (2012), Professor Carl Steinitz of Harvard University, the origin of the term "Geodesign" is not well defined. Some sources indicate Kunzmann (1993) as the first user of the term to mention spatial scenarios and discussion of opportunities and threats, with a view to urbanization for European metropolises (Fonseca, 2016).

For Carl Steinitz (2012) - the author of the framework - Geodesign is based on some questions and develops in a certain structure to solve complicate and relevant design problems in different geographical scale. Steinitz has created a "framework" to apply better the Geodesign concept. Its workflow is dynamic as Geodesign can be applied to any context but rarely with the same structure (Steinitz, 2012). It is essential to create a interdisciplinary team that should consider also the people of the area of application (Fig. 1).

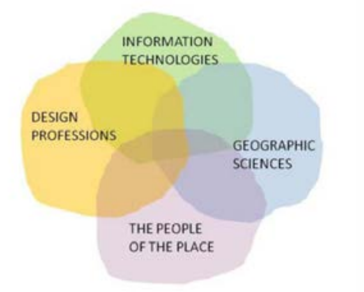

Fig. 1: Team of Geodesign and the framework. Source: Steinitz, C., 2012

Steinitz formulated a methodological structure focused in six elementary questions that are guidelines for the entire process. To answer to each question Steinitz created six models. Each one is referred to one question for three times, along the adjustment process and are of Representation, Process, Evaluation - that represented the 'assessment' phase -, Change, Impact, Decision - that represented the 'intervention' phase (Fig. 2). Each time is called "iteration" and answer to:

- "Why?" - analyze the area of study;
- "How?" - definition of the methodology;
- "What? Where? When?" - realize the plan.

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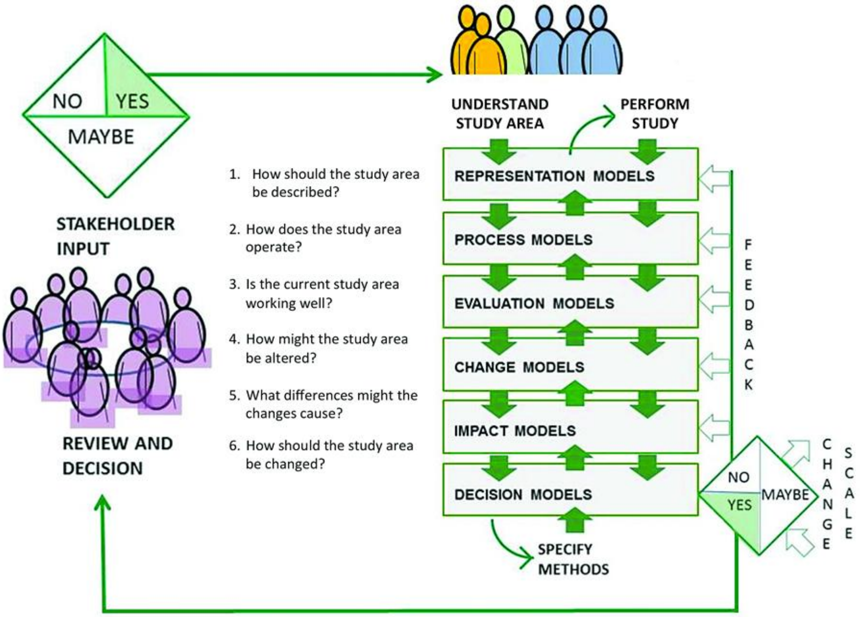

Fig. 2 Framework of Geodesign by Carl Steinitz. Source: Steinitz, 2012

The methodology is flexible so there isn't a rigid procedure for each model: the way to develop each models doesn't follow a fixed structure. The framework for Geodesign was created to realize participatory projects, involving all the actors in the process and respecting the different opinions. This methodology is totally different form the traditional and linear procedures, because, according to Fonseca (2016), in the framework is possible to return to the previous steps at any time and this doesn't represent a waste of time but a gain of knowledge for the studied area. Therefore the Geodesign method is also adaptable to the object of study. The application of this framework is becoming increasingly used all over the world and it is an evolution of the way to plan the territory, "with" and "for" it, integrating planners and social actors (Fonseca, 2016).

4 DEVELOPMENT OF *MILLENNIALS* WORKSHOP FOR *DANDARA* OCCUPATION

4.1 THE CASE STUDY

The Dandara occupation just turned 9 years. It was established in April 2009 organized by the Housing Forum of Barreiro, People's Brigade, Landless Workers' Movement (MST), Land Pastoral Commission and also received the support of the Legal Aid of Minas Gerais State and of the Juridical Assistance Service of PUC-Minas. And last, but not least, the support of architects, town planners and students of UFMG and PUC-Minas Universities to design of the urban plan in the first months of occupation2 The Dandara can be

[2] More detailed information about *Dandara* occupation: Branco, 2014.

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considered as one of the biggest land conflicts in the Minas Gerais State and has gone through many difficulties before becoming what is today.

The land is located in the Céu Azul neighborhood, in the prime district of Pampulha, in the Northern region of Belo Horizonte (Fig. 2).

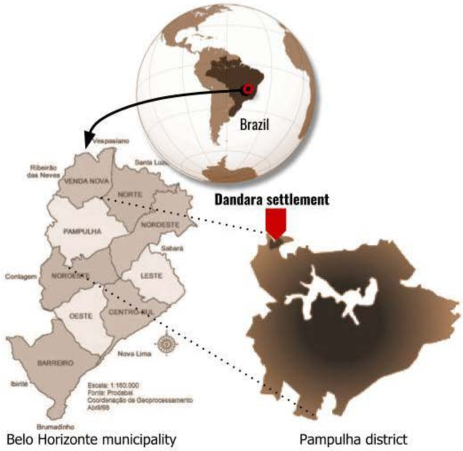

Fig. 2 Localization of Dandara occupation. Source: Authors

The occupation is close to the metropolitan borders of Belo Horizonte, Ribeirão das Neves and Contagem. The neighborhoods around the area and close to the Pampulha lake area are of middle class families. The other ones belong to lower and lower-middle classes. The occupied area is 315.000 m² large and had been vacant since the 1970s - although it is ownership of a construction company- . That's because the real estate market wasn't interested in investing there because of the legal restrictions for building and increasing the population of the area. So in this context the *Dandara*'s movement began in order to give the social function to the property and obviously offer housing for those who needed. *Dandara* became well known and popular for the media and it's still under investigation by several fields of study such as social and political investigation and urban planning. The occupation and parceling plan was elaborated by a technical team together with the residents. The original plan considered collective plots to facilitate the placement of many dwelling as much as possible. But the residents insisted to receive individual plots and so the number of houses was drastically reduced. Furthermore were left free areas for future public equipments and the permanent preservation area (APP) was left unoccupied as required by federal law (Law n° 12.651/2012[3]). The success was so huge that new plots demand increased exponentially.

This circumstance led to the parceling of the public area and as well as the occupation of a part of the APP. Today the *Dandara* occupation has 3.336 habitants, as reported in the second census by the Developer and Housing Company of Belo Horizonte (Urbel) in 2017.

[3] Senado Federal, Law n° 12.651, of 25 May 2012. Dispõe sobre a proteção da vegetação nativa, Brasília, DF.

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4.2 PREPARATION OF THE WORKSHOP

The framework application was realized with a majority participation of Millennial students of School of Architecture and Urbanism of UFMG. The workshop lasted for only 8 hours and took place in the Geoprocessing Laboratory. Before a workshop application is necessary to organize the data and the processes which has already been discussed in the chapter 3. In the "Representation Model" were gathered information about the area, which the Belo Horizonte Municipality had already produced for the previous workshop or had been deducted by the fieldwork or as well as produced by the authors. In this phase are defined the systems to describe the area. Basically these are guidelines for develop of the proposals, as they're constituted from a set of variables that characterize that area and its dynamics. The systems applied in this workshop were generic and symbolic and concerned the main issues to be discussed: History/Cultural, Agriculture, Blue Infrastructure, Green Infrastructure, Gray Infrastructure, Energy Infrastructure, Industry, Housing, Commerce, and Institution.

All these systems were adapted to the specific reality of the occupation: the Historical/Cultural was referred to their remembrances linked with the occupation or Industry considered the opportune areas for local production. The next step was the "Process Model", the variables for each system were defined and processed to understand the area dynamics. Then, in the "Evaluation Models" were produced the evaluation maps, that were used as diagnostic references by the participants during the workshop, as they show the potential areas suitable for new proposals.

4.3 THE DYNAMIC OF THE WORKSHOP

The workshop began with a short slide presentation about the dynamic of the experiment: a presentation of Geodesign methodology and of the area and then showing the Evaluation Maps produced by the authors explaining which variables were used to produce each one. Then the participants were divided in groups that were distinguished for the way they produced proposals for the area. This group definition became directly from the methodology author, Carl Steinitz, who promote Geodesign workshops all around the world using the same structure: the scale of the case study, the groups typology and the time frame of the two shifts.. The *Dandara* case study is the smallest scale of a totality of three different sizes scenarios. The types of groups are:

- "Non Adapter": in the proposals making phase, who belong to this group, assumes that neither the policies nor the way to plan will change in the future. So the proposals will be more reasonable and follow the current legislation;
- "Late Adapter": this group assumes that the policies won't change as well, but only in the first shift of time. In the next and last one, after the traditional version, they could begin to suggest more innovating projects;
- "Early Adapter": they propose in a forward-looking way from the beginning.

The first time frame is a near future from the present (2018-2020) to 2035. Then this first shift, will be produce a project for each group, all projected for the 2035. In the second shift the projected future is until 2050. It is in this one that the second group, the Late Adapter, begin to propose more progressive and contemporary projects, as well as the Early Adapter (Fig. 3).

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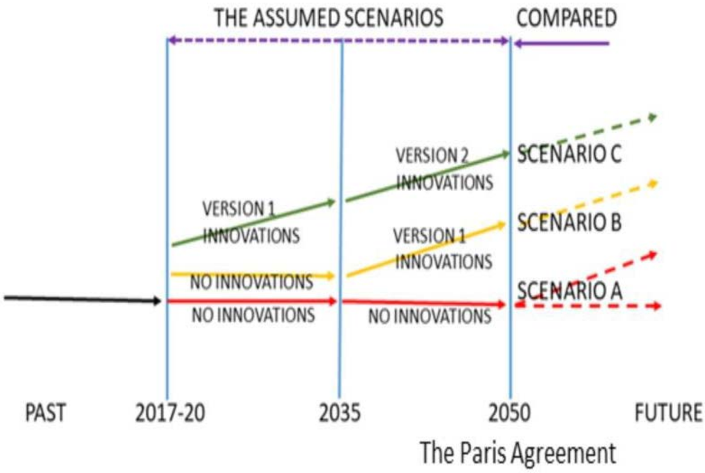

Fig. 3 Temporal logic and groups dynamics. Source: Carl Steinitz. https://en.wikipedia.org/wiki/Paris_Agreement

These dynamic was explained during the workshop to the participants. So they start producing proposals for the Dandara occupation using the Geodesignhub web platform. This is the tool through the participant can sketch their ideas for each system. The projects are constantly synced in real time so everybody can visualize in the screen what is going to be created by the different groups. In order to support and help the decision making, increasing the understanding of the area, they can consult the Webmap tool. This is a visualization and interaction map tool via internet in geographic information system. There were the main contextual bases of the area and the evaluation maps as well. This tool aim is to pass information to support and facilitate the decision making process and it has a big potential: it takes advantage from the users' ability to use social media and internet to transmit important information that will contribute in the discussions about the space to be planned and managed. They also use the Google Earth platform where they be able to visualize satellite pictures with a better resolution (Fig. 4).

Fig.4 Pictures from the Geodesign *Millennials* workshop. Source: Authors

The totalities of the diagrams start appearing sequentially during the workshop. Later, all these products were examined and each group designed a project for the 2035 with their own point of view: Non Adapter (NOAD), Late Adapter (LAAD) and Early Adapter (EAAD) (Fig. 5). As they finished their first projects they were invited to have a comparative analysis between the projects, considering also the impacts. This can be done, for example, observing how much is the areas percentage for each system. As can be noted in the previous image, the traditional group (NOAD) had a lot of proposals for the Habitation system compared to the third group (EAAD) who did so much more projects for the systems related with the infrastructure, in

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this case Blue and Green Infrastructure. They also didn't provide diagrams for the Energetic and Habitation systems and this can be observed in the image above as well: in the impacts chart the columns for these two systems are without representation.

Fig. 5 The first three projects for the 2035 designed in the Geodesignhub platform. Source: https://www.geodesignhub.com/p/60a67109b11aa401/design/

So each group finalized the first round with a project that better represented its concept. Later they were invited to create more diagrams but considering the long term for 2050, point out another time that the Non Adapter must continue to plan in a traditional way and the others (Late and Early Adapt) should be more progressive and revolutionary planners. As happened for the first round also at the end of the second, each group developed a new project for 2050. Finally it's the negotiation time. First, the workshop master starts present all the frequency diagrams to encourage the negotiation discussion and then the final diagrams that will create the final project. The frequency diagram (Fig. 6) reports the frequency of the vocation for each diagram, from proposal that obtained three votes - that it means that all the group voted for it - to diagrams that got only one vote - so only the group who design it vote for it. In this negotiation the diagrams with 3 votes weren't discussed collectively because everybody agreed with those ideas, and entered directly in the final project. Using the same logic the diagrams with only one vote were discarded. The proposals that received two approvals could be discussed between the participants.

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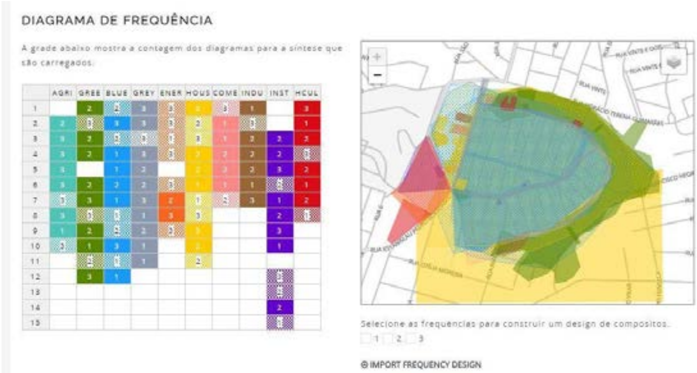

Fig. 6 Frequency chart for the 2050 projects
Source: https://www.geodesignhub.com/p/60a67109b11aa401/design/

In the negotiation, run by the master, the group who didn't approve that proposal could explain its reasons and the ones who voted for it could convince them of the proposal's relevance.

So in this case could be noted that the frequency vary from 1 to 3; this depends the number of the groups involved in the workshop. In GeodesignHub is possible to work up to ten groups, so that produces a possible frequency variation from 1 to 10 and so the negotiation become increasingly difficult, as the opinions and ideas are multiplied as well. At the end of this phase is produced a final shared project where are included the ideas and proposals created and chose by all the participants. Through the collective and collaborative work the *Millennial* co-created a pilot project of alternative futures for the *Dandara* occupation projected until to 2050 (Fig. 7).

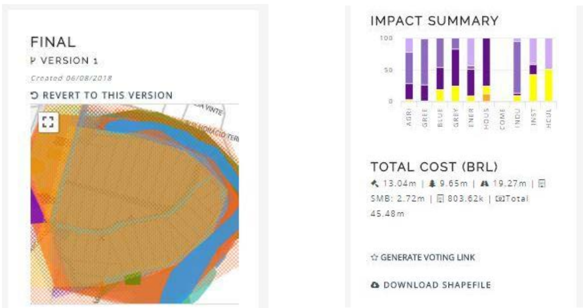

Fig. 7 The final project for 2050 and its impacts chart.
Source: https://www.geodesignhub.com/p/60a67109b11aa401/synthesishistory/

5 RESULTS

The Geodesign workshop with the Millennial was an academic experiment, the purpose of which was to compare the performance of different participants' profiles, facing a precarious situation that needs a urgent upgrading through Geovisualization technologies as support for these transformation planning. Furthermore, can be noted the participation of each member involved in the co-creation process, confirming that all the

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participants play an important role contributing with their ideas and experiences to design interesting proposals coherent with the needs of the area.
Observing the Millennial contribution in this workshop, it is notable their comfort and rapidity with the offered web-based platforms, also adding the use of other sources of information - such as Google Earth or just using search engine tools - looking for more knowledge about the area or inspiration for the proposals to do. In the workshop with the local young of Dandara these different tools weren't used by the participants as support, although they were offered by the workshop masters (for more information about this workshop, consult: DE PAULA et al., 2017).
This could be explained by their deep knowledge of the area and the awareness of its problems. The Millennial who participated in the workshop were students of architecture and urbanism, so they were able to act as space planners. They started examining the contextual information to already produce a diagnostic mental map to build on these bases, so the ideas started to come up. Therefore, it's worth highlighting that their lack in knowledge of the real settlement condition was real, but despite this, they were still be able to produce interesting proposals. That can be explained by their academic background as future planners.
From the co-created projects can be observed that they answered to the basic necessities, as the occupation needs the implementation of the basic infrastructure, but, apart from this, they promoted to improve the urban quality for the residents. The most of the proposals are feasible and focused in environment, urban and community quality. The students planned projects and policies to encourage social activities, as cultural spaces; leisure centers; policies of environment education and land use as a means of production; support center for the families, children and elderly; incentives for sustainable activities.
If part of these projects and policies will be implemented, this entire region around the occupation will take advantage of this, thus creating a excellent qualified area. Reflecting on the projects of the local workshop is easy to perceive a huge difference in the proposals from the creative and qualitative standpoint. That's way the people of the place influences the decision making process so much more that the other involved actors, reducing the project to the main urgent problems to be solved. It is worth pointing out that the need of basic infrastructure takes the attention off the urban space, social activities and sustainable practices, as the real emergency to have electricity, running water, sewer system. Can be realized that the Millennial have a more developed creativity, and this is maybe because they represent a more positive generation, always have been using technological tools and they are academic actors. So it's normal that their ideas were more progressive, also highlighting that they knew to be part of an academic experiment so, although the focus was in a real area, they felt more detached from reality, and additionally there wasn't any budget to be considered. Analyzing the use of the web-based tools, can be perceived that are really useful as decision making support. More the information is complete and well explained; more will be the participant's comprehension and interest for the considered issues. The improvement in the visualization and interaction during the workshop was particularly remarkable. According to these points, the interactive map available via the web gave new channel of information, strengthening the way to make these data available to integrate the participatory planning, as in this case study just explained.

6 CONCLUSION

The Geodesign methodology fulfilled its role of catalyst for ideas and proposals made by a group of people with different opinion, to achieve a shared agreement materialized in a final co-created project. Can be concluded that the used platform make the decision making process so much easier.

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The Geodesignhub has a good visualization and its support to reconcile consensus is undeniable. What really can't be substituted is the face-to-face debate, that's the most important moment in the negotiation phase. So it's clear that the web-bas platform make a online workshop possible with dislocated participants, but the debate live contribution enriching the quality of the results so much that it is an issue that should be revised. About the quality of the ideas of the *Millennial* workshop can be observed that there are an improvement in the quality ideas especially those relating to environmental sustainability and incentive for social activities that improve the sense of community.

It didn't happen in the workshop with the locals because, as has already been mentioned in the results, the academic and social background strongly influenced the results.

The improvement of the quality of a urban regularization plan in such as urban situation, could be achieved by increasing the creativity of the people of the place, as they are no used to face this kind of mental practice. The introduction of some prearranged proposals created by planners also could be a starting point to show to the participants, especially the unqualified people, a way to create a more qualified plan that meet all of the requirements.

But this practice could be dangerous for the possibility of manipulate the people's decisions with preset ideas. Finally what makes the two experiences really different was the participation of these people: the *Millennial* couldn't have a proper knowledge of the area because they had never experiences situation like those and faced those kinds of problems.

So can be finally affirmed that the participation of the people of the place is essential in any kind of scenario to be planned, especially if it's considered the use of a participation planning methodology such as the Geodesign framework and a *favela*, *vila*, occupation scenario.

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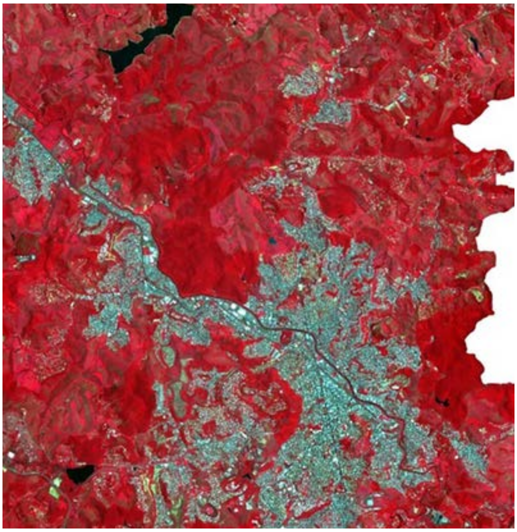

FROM THE LOGIC OF DESKTOP TO WEB SERVICES APPLICATIONS IN GIS

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ABSTRACT

Design planning in cities in collaborative approach requires holistic thinking about urban space. It is important to recognize specificities of the territory and to understand that cities are complex ecosystems. Cities can be represented by models that are portraits of reality, according to spatial, temporal, conceptual and methodological simplifications. Using models, it is possible to select main variables and parameters of the place, to identify relations among them, and compose structures that represent main characteristics, vulnerabilities, attractiveness, and essence of the place. Our goal of the research was to produce of a minimum collection of spatial data in urban areas, to be used as basis for master plans and site management. The study proposes the use of free access data, reached in data warehouses by scripts, based on web map services, and automatically construct evaluation maps to be used in geodesign studies. Using evaluation models, the participants design the future of the place. We constructed scripts to produce a group of first data and evaluation systems, about themes that are used in the majority of the case studies (green systems, transportation system, urban system and, agriculture system), so that any user can have access to dynamic data, produced by demand using the most recent information available in data warehouses. In this sense, users don't need to be GIS experts, but only GIS consumers, only freely accessible data will be used, and the municipalities will be able to have a minimum collection of dynamic evaluation models about their realities.

KEYWORDS

Geodesign; Urban Planning; Collection of Spatial Data; Web Maps and Web Services

1 INTRODUCTION

Design planning in cities in collaborative approach requires holistic thinking about urban space. It is important to recognize specificities of the territory and to understand that cities are complex ecosystems. Cities can be represented by models that are portraits of reality, according to spatial, temporal, conceptual and methodological simplifications. Models become even more important in the era of technologies of geoinformation. It is necessary to think of new proposes about land use and the necessities the people of the place – considering cultural values and genius loci – requiring the ability to project not only on local scale, but also considering the scale of the territory. Thus, to build effective interventions, is important to respect the specific features of the territory and to understand that cities are complex ecosystems comprised of abiotic and biotic elements. They are always interacting in time and space and are unique to the space.

In short terms, cities can be represented by models that are portraits of reality, according to spatial, temporal, conceptual and methodological simplifications. Using models, it's possible to select main variables and parameters of the place, to identify relations among them, and compose structures that represent main characteristics, vulnerabilities, attractiveness, and essence of the place

The conditions to explore technologies of geoinformation started with GIS - Geographic Information Systems in the 60's. In the begging, the goal was to combine geo-referenced layers, followed by the possibility of associating alphanumeric data resulted in proposing scripts and more complex combination of variables. Important changes came with the inclusion of geoprocessing tools in the software, to apply spatial models, based on map algebra, combining data about variables and reading their specific parameters. (Eastman et al., 2011; De Magalhães, 2013). The application of GIS associated satellite images data allowed the digital information processing, with high and medium spatial resolution (low cost and high frequency) products when compared from classical aerial photogrammetry (high cost and low frequency). It contributed to studies about land cover and vegetation cover. Nowadays it's possible to find free data services, contributing to the democratic accesses to the data (de Bessa, 2005). Although, even with all the facilities in the use GIS and to get free access to data, most of the municipalities are not able to produce their thematic maps. To use the tools and data about geographic information it is required specific knowledge about technical resources and methods to manipulate data and produce information. Our goal of the research was to produce of a minimum collection of spatial data in urban areas, to be used as basis for master plans and site management. The study proposes the use of free access data, reached in data warehouses by scripts, based on web map services, and automatically construct evaluation maps to be used in geodesign studies. Geodesign is a method to promote co-creation and co-planning of alternative futures to an area, that requires a minimum collection of information about the place, known as evaluation models, that tells if the area is working well. Using evaluation models, the participants design the future of the place. The idea is to avoid using desktop geoprocessing tools, in which data and software are stored in the personal computer of the users, but to provide a web service that gets the data from a database and applies a script that represents the algebra that produces the evaluation map. There are some advantages of it: data will be always the more updates one, users don't need to be GIS experts, only freely accessible data will be used, and the municipalities will be able to have a minimum collection of evaluation models about their realities. The idea of this study came in two previous opportunities: when Geoprocessing Laboratory contributed in a project from the Ministry of the Cities in 2016. After that experience the group of the geoprocessing laboratory realized that the same logic of solving the problem of providing evaluation analysis about the main themes on a case study could be quite useful to geodesign process. In the project with the Ministry of the cities, the goal was to give support to all the municipalities in

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Brazil to construct evaluations about feasible and not feasible places to construct housings to attend to the program "Minha Casa Minha Vida". It was important to create an easy way for them to construct their thematic evaluation maps, analyzing the possibilities of places to install the housing program, according to main variables (presence of services, infrastructure, avoiding clusters with other housing units, with accessibility to the urban area, and so one). As most of them were not GIS users, the project created scripts with the use of ETL tools (Extract Transform and Load) so that the thematic maps, classified according to the suitability to receive the houses. As a result, all the municipalities produced the same thematic maps, according to the same methodologies, and the federal government was able to compare results and analyze the information.
The second experience happened in several workshops conducted by Geoprocessing Laboratory using Steinitz's Geodesign framework and the web-platform GeodesigHub©. According to Steinitz (2012), geodesign is a method to project with and to the geography, which is based on 6 steps, composed by models: representation, process, evaluation, change, impact and decision. A group of defined actors (people of the place, administration, technicians, and representatives from different sectors of society) take part in a workshop to construct alternative futures to the place. As basis to the discussions, they receive evaluation maps, which are thematic maps according to main vulnerabilities and attractiveness of the place. In our workshops, as we are senior users of GIS, we didn't have difficulties in producing the representation, process and evaluation maps, but we realized that, if another group was conducting the experiment, that could be a trammel to be solved. And this is the reality of most of the municipalities in Brazil: lack of knowledge and resources to produce evaluation analysis and thematic maps. After these experiences, we decided to write the main steps to be followed by any researcher, through two methods: the traditional desktop using GIS and the webased using the digital platforms to create the evaluation maps. From those collections of steps, Ballal, the programmer of GeodesignHub, constructed web map services, which are scripts that get data of free access in warehouses and transform them according to map algebra, producing evaluation maps. Scripts like this will provide basic maps to any geodesign user, that will not be required to be GIS experts to propose and to organized workshops. A group of main thematic was structured, and in the future all main systems can have their initial maps easily done. The first systems produced were: green, urban, agriculture, and, transportation. In the future, the 10 basic themes to receive this kind of support must be: history/cultural, agriculture, blue infrastructure, green infrastructure, gray infrastructure, energy infrastructure, industry, housing, commerce and institutions.

2 METHODOLOGY

The methodology to produce the evaluation maps was developed from two main methods: the traditional method desktop using GIS and the using the digital platform cloud based webservices maps. The systems elaborated in this study were developed from the basic maps with open access data to give support to produce the systems the accessible way to city halls in support of its master plans. Thus, the methodology was divided in two steps: the traditional method using desktop and, the webservices to produce the evaluation maps.
The methodology used to produce the system were – Green system, Transportation system, Agriculture system and, Urban system. The Green system aims to identify the green areas existents and the protected areas. This system is important to manage the green areas existents and promote its protection and development. The transportation system aims to identify the main street access, highways and access to the city. This system is important to develop strategies for public and private transportation management. The agriculture system was developed to identify the potentialities of land, the water resources and, the best location to drain agricultural production, this system is important to develop strategies for agriculture, access, transportation and, trade in

Enviromental and territorial modelling
for planning and design

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agricultural products. The urban system was developed to identify the different types of land use, green patches, water resources existent, and impervious and pervious areas in the city. This system is important to develop strategies for urban management, urban growth, and potential areas to industry, housing and others.

2.1 TRADITIONAL METHOD USING DESKTOP APPLICATIONS

First, it was necessary acquire the data to elaborate the basis maps (Fig. 1) using the cloud-based geoprocessing system. Very used web platforms to get georeferenced that are those from Nasa and USGS[1], Copernicus Project[2] and we can also mention Actinia[3]. After the data acquisition, the pre-processing step followed. The Sentinel image was used to produce the green maps through the NDVI index. The slope map was derived from the NASA SRTM elevation data. The data from "OpenStreetmap.org" was used to create the street network map, and the water data was obtained from the official government database. Then, the data processing step which included based on land use and land cover, slope, water resources and roads started in order to get the results. To illustrate this study, we will use, as a case study, Juiz de Fora, a medium-sized city of Minas Gerais, in Brazil (Fig. 2).

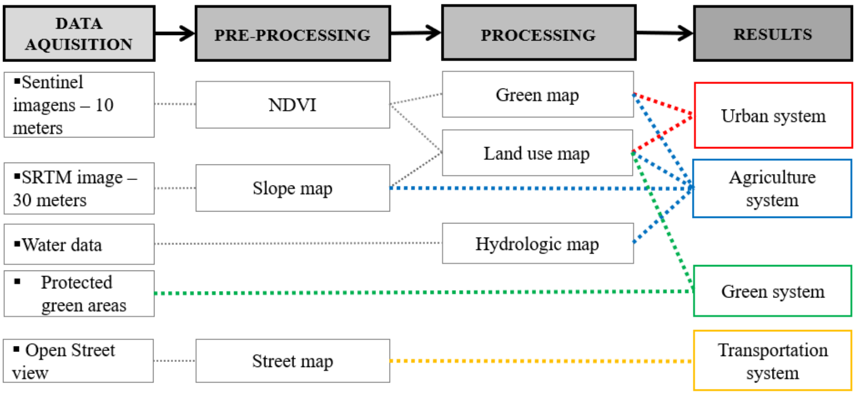

Fig. 1 Methodology framework. Source: Authors

<u>The use of satellite images – Copernicus sentinel – 2</u>

The satellites Sentinel-2 of the European Copernicus Mission collected the data to needed produce the NDVI map of the year 2017 (10 meter resolution). This satellite has the mission to monitor variability in land surface conditions, and its wide swath and high revisit time supporting and monitoring of changes to vegetation within the growing season[4]. The Sentinel-2 satellites were designed by a consortium of around 60 companies led by Airbus Defense, in the Copernicus Mission by the European Community. This satellite had as its mission, monitoring variability in land surface conditions, and its wide swath and high revisit time (10 days at the equator with one satellite, and 5 days with 2 satellites under cloud-free conditions which results in 2-3 days

[1] https://earthexplorer.usgs.gov/
[2] https://scihub.copernicus.eu/dhus/#/home
[3] https://www.mundialis.de/en/actinia-geoprocessing-cloud/
[4] Corpenicus Mission, 2015.

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at mid-latitudes) support monitoring of changes to vegetation during the growing season. The coverage limits are from 56 ° south and 84 ° north (Corpenicus Mission). The Multispectral Instrument (MSI) on-board SENTINEL-2 undertakes systematic acquisition in a single observation mode, operating in 13 spectral bands, four of which are in the electromagnetic spectrum known as "visible", the other bands covering near and shortwave infrared at different spatial resolutions ranging from 10 to 60 m. These following bands are relevant for vegetation monitoring: Red (band 04) and near infrared (band 08), which can identify changes in chlorophyll levels and plant cell structure. Due to these characteristics, Sentinel-2 satellite images are suitable for separating vegetation from other land uses, as well as to classify different phenological conditions of vegetation cover in those bands the spatial resolution is 10 meters.

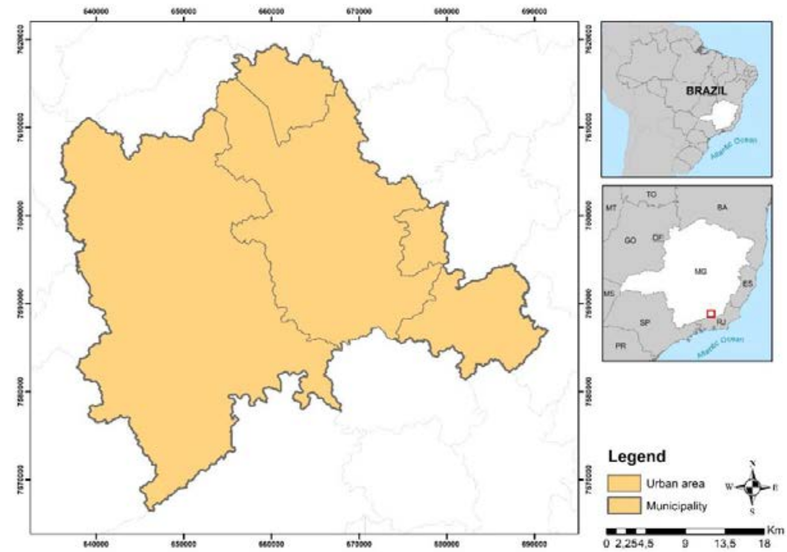

Fig. 2 Case study – Juiz de Fora Municipality, Brazil. Source: Authors

NDVI (Normalized Difference Vegetation INDEX)

From the selected Sentinel-2 image scene (June 2017), we used the band 4 corresponding to the red band and band 8 corresponding the infrared band commonly used to calculate the NDVI index via band algebra, according to the following formula (1):

$$NDVI = (\rho ivp - \rho v) / (\rho ivp + \rho v) \qquad (1)$$

Where: ρivp is the reflectance in the near infrared; ρv is the reflectance in the red.

The NDVI is based on the spectral signature of the target's behavior. Vegetation presents specific responses related to photosynthesis the process of absorbing solar radiation in the red range of the spectrum. The plant cells reflect more strongly in the near infrared range. Variations in plant condition are identifiable due to the portions absorbed in the red and reflected in the infrared. We can associate them with other normalized indexes to make correlations and verify the studied place's ambiance as well as improving its management (Freire & Pacheco, 2005; Myneni et al., 1995; Rocha et al., 2016; Rouse et. al., 1973).

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The NDVI result it is a normalized index, the resulting image distributed between -1 and +1 values. When the result is closer to -1, it has a weaker spectral response in infrared bands, and we can conclude this is water, exposed soil, shadow and impermeable areas soil, all of which have a high coefficient of runoff. When the result is closer to 1 the stronger spectral response identifies the type of vegetation (Fig. 3).

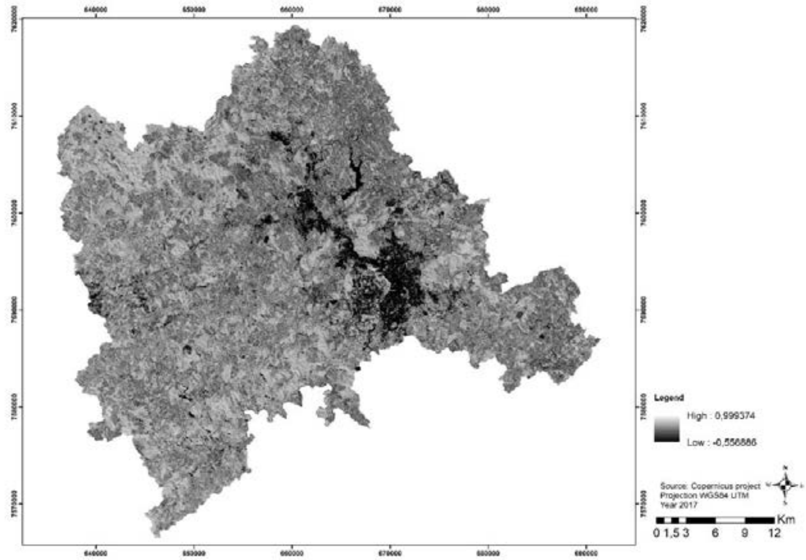

Fig. 3 NDVI map, Juiz de Fora municipality, Brazil. Source: Authors

From NDVI classification index, we could classify in ranges of land use and vegetation existent, that is, in yellow is the land use without vegetation, exposed soil, building, shadow or water; the grassy land cover is in orange; the shrubbery vegetation is in pink, and in purple is the dense vegetation (Fig. 4). The classification can be based on supervised methods, using samples, by Natural Breaks separating tendencies or by Maximum Likelihood. We tested both, and the results were quite similar, that's why we decided for the first method.

<u>SLOPE MAP</u>

To produce the slope map, SRTM elevation data were used (NASA Shuttle Radar Topography Mission, Global 1 arc second data, V003 at 30 meters of resolution) to extract contour lines at 5 meter levels (Fig. 5). After that, we classified the contour according to the ranges of slope as 5%, 13%, 30%, and 47% according to Brazilian reality (Fig. 6).

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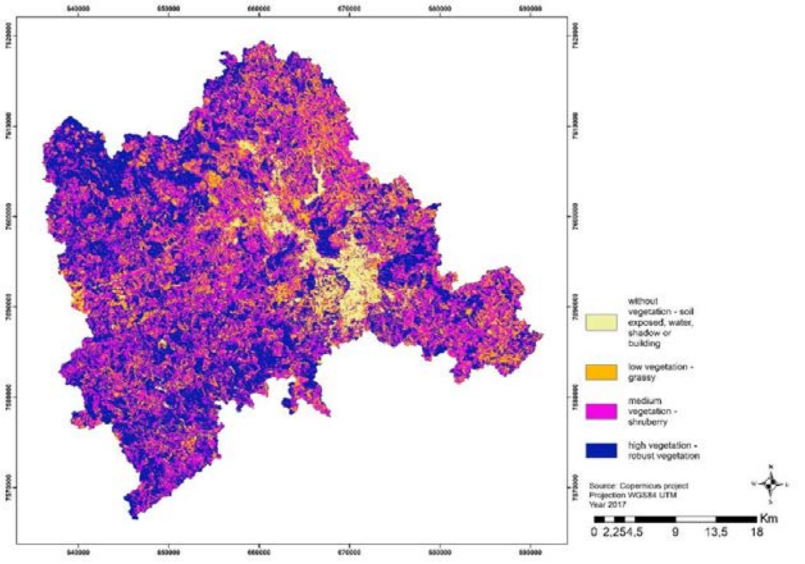

Fig. 4 Land use map, Juiz de Fora municipality, Brazil. Source: Authors

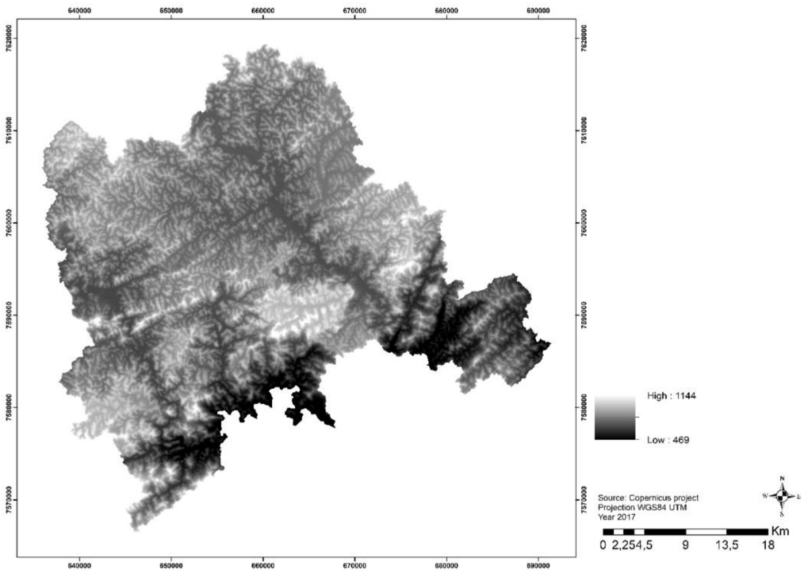

Fig. 5 SRTM elevation map from case study. Source: Authors

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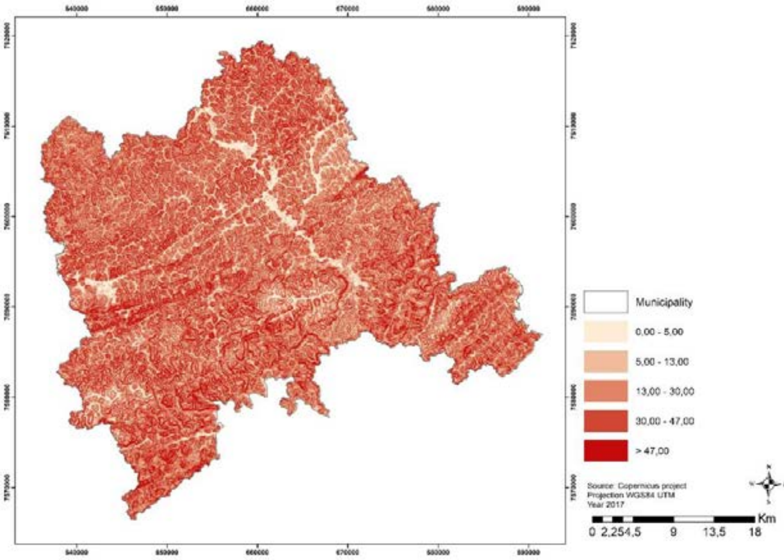

Fig. 6 Slope map derived from SRTM. Source: Authors

<u>STREET Network</u>

To produce the street network map, we downloaded data from "OpenStreetMap" (https://www.openstreetmap.org/) and selected the lines referring to the street, according to the case study (Fig. 7).

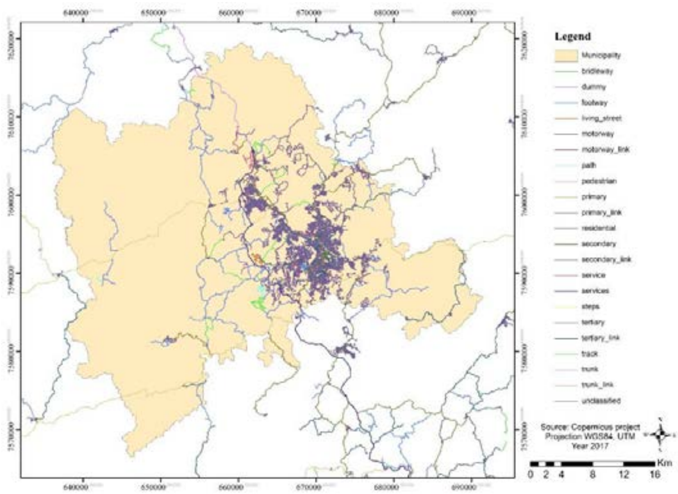

Fig. 7 Map of street network. Source: Authors

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Hydrological map

To produce the required hydrological map, it was necessary to consider the existent data according to the researcher’s decision or the local conditions. In Brazil, using open access data from ANA (Brazilian National Water Agency), we downloaded these data and selected all the watershed and rivers from the municipality of Juiz de Fora (case study). After that, we calculated the watershed area and river area in square meters added to the length to discovery the density. The result was classified in three ranges: low, medium and high (Fig. 8).

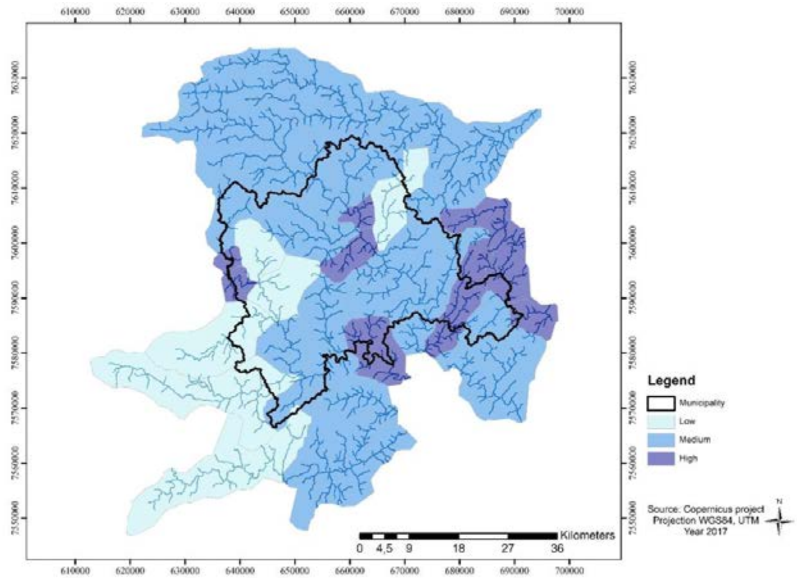

Fig. 8 Water map. Source: Authors

Combinatorial analysis

To apply the Combinatorial Analysis, we will use as an example the Urban system (Fig. 9). According to Oliveira Groenwald et al. (2009) combinatory analysis "... is the part of Mathematics that studies and develops methods for solving problems involving counting or existence, in general, it can be said that it is the part of Mathematics that analyzes discrete structures and relations". This method allows adequate aid for the analysis of the study with the combination of different variables (Rocha et al., 2016). It is important to highlight that each researcher can make their variable combination according to the feature of their research and this matrix serves as a guide to maps with algebra logic.

In the combinatory analysis result, we will use the colors by Steinitz's geodesign framework to produce an automatic algorithm to be applied to the evaluation maps in the GeodesignHub©, however, according to the need of each map, there will not always be the five colors indicated.

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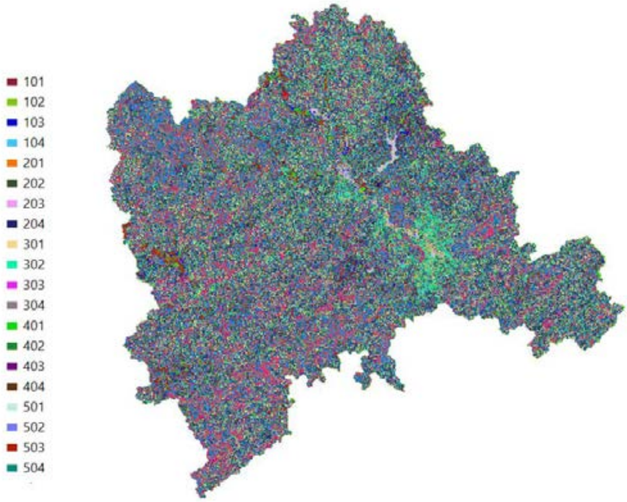

Existing impervious area: 101, 201, 301, 401, 501

Not suitable/inappropriate to urban growth: 502, 503, 504, 104, 204, 304, 404

Capable to urban growth: 402, 403

Suitable to urban growth: 102, 103

Feasible to urban growth: 202, 203, 302, 303

SLOPE \ LAND USE		Impervious areas/ Land exposed/ water and shadow	Grassy	Shrubby	Robust
		1	2	3	4
0-5 %	100	101	102	103	104
5-13%	200	201	202	203	204
13-30%	300	301	302	303	304
30-47%	400	401	402	403	404
> 47%	500	501	502	503	504

Fig. 9 Combinatorial analysis the Urban system. Source: Authors

2.2 WEBSERVICES MAPS

Sentinel data is a publicly available from a number of data sources such as Google Cloud[5], Amazon AWS[6] or Sentinel Hub[7]. Traditionally, imagery from these sources is downloaded on desktops and processed in Desktop GIS. The dataset from Sentinel is large and one scene is almost 650MB in size and the data is being updated daily. The pace at which the data is growing, and the size of data necessitates a new way to access and process them. This is where GIS as a service in modern cloud computing infrastructure is useful. Instead of using downloading and processing imagery on desktop GIS, commands are run in the cloud-based GIS system for a remote and fast processing. Here the outputs can either be downloaded after processing or accessed as Web Services.

[5] https://cloud.google.com/storage/docs/public-datasets/sentinel-2
[6] https://registry.opendata.aws/sentinel-2/, since May 2018 access to be paid
[7] https://scihub.copernicus.eu/

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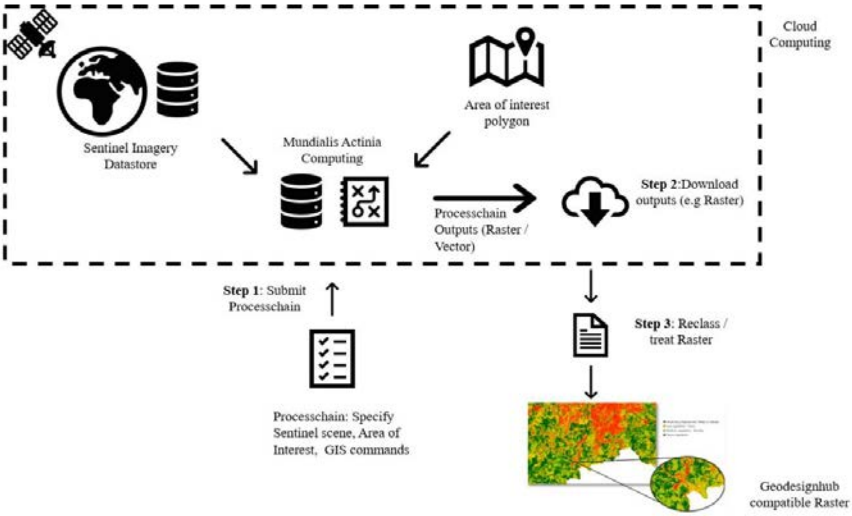

Fig.10 Diagram of webservices applications. Source: Authors

This method of working provides a number of advantages (Fig.10):

- it utilizes the greater computing capacity of servers and cloud computing;
- advanced caching and optimizations can be performed in a networked environment;
- it enables use to "chain" different commands together automatically, submit the job and then download the job once the steps are completed.

Mundialis[8], a company based in Bonn, Germany has built such a cloud computing system that enables "GIS as a service" in the cloud software. This innovative platform is called Actinia[9] and supports a wide array of geoprocessing. The Actinia platform leverages the vast experience that Mundialis has on GRASS GIS and cloud computing. It is cloud-vendor agnostic and provides a programmable interface (REST API). Through the EU H2020 project "openEO"[10] the backend development for the Sentinel data processing is further developed.

Geodesignhub partnered with Mundialis to develop an open source processing chain to build these evaluation maps using cloud computing. The open source code is hosted here: https://geodesignhub. github.io/Sentinel-Evaluations-Generator/. The software has two major components. The first component is to utilize Actinia to process Sentinel imagery in the cloud using "Actinia Processchains". Once the cloud computing operations are completed, the software downloads the generated images to the desktop and further processes them to perform operations like re-classing etc. to make them compatible with Geodesignhub taxonomy and classes. The second component of desktop processing can also be done on the cloud but for this initial trial, the authors decided it would be better if it was done after downloading to enable easy testing and debugging. The software

[8] www.mundialis.de
[9] https://www.mundialis.de/en/actinia-geoprocessing-cloud/
[10] http://openeo.org

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uses open source libraries to do this reclassing and post cloud treatment. The primary inputs to this software are a polygon denoting a "Area of Interest" and a ID of the sentinel scene. Finding the appropriate sentinel scene can be quite tricky given the cloud cover limitations. The appropriate scenes can be selected by using the Sentinel Hub or any of the services mentioned above. Processchains are an innovation of the Actinia platform that enables a whole range of Geo-processing operations on the cloud. These JSON based commands are understood by the GIS software (GRASS GIS; Neteler et al., 2012) in the cloud and uses them to chain different operations using outputs from one operation as a input to the next operation. In addition, detailed logging and debugging can be undertaken using this technique. When coupled with other web / service based tools like Geodesignhub dynamic on demand geo-computing can be performed. In a design environment like Geodesignhub this means that impacts of design interventions and design synthesis can be computed in realtime using advanced models and the results can be generated and transmitted in near realtime.

3 RESULTS

After applying the combinatorial analysis, we got to the systems, the evaluation maps. To show the results we used the colors indicated in the evaluation map used in Steinitz's framework geodesign. In the Urban System (Fig. 11), it was applied the combinatorial analysis between the NDVI map with the slope map. In this system, it was observed the best areas to urban growth without harming the existing main wooded areas (robust vegetation). The label "existing", in red, indicates the impervious areas, occupied areas with buildings, water or exposed soil, that is, to where a consolidated urban area already exists; the "not suitable" range (in yellow), indicates the robust vegetation existent and/or slope with more than 47% of protected areas, so this range is not indicated to urban growth. The "capable" range (in light green), indicate the areas that can accept urban growth, but they are conditioned to a favorable report geotechnical control because they are areas of risk of landslide. The "suitable" range (in medium green), indicates the areas that can accept urban growth, as long as precautions are taken, because it is located at the flood risk areas. The "feasible" range (in dark green), indicate the areas with a favorable slope without compromising the existent robust vegetation to the detriment of urban growth. In terms of combinations, the Agriculture System (Fig. 12) is the most complex system. It was applied the combinatorial analysis to understand the relation between the land use map, slope map, and hydrologic map. In that system, there is not the red range (that indicates the existing areas) because there are not restricted areas to agriculture, but rather areas conditioned to the existence of water resources, adequate slope, and next to existent urban areas, allowing the mechanization of agriculture, and the family farming without damaging the protection areas. The range "not suitable" (in yellow), indicates the areas with low potential to agriculture development; the "suitable" range (in medium green), indicates the areas with the medium potential to development of agriculture; and the "feasible" range (in dark green) indicates the areas with high potential to development of agriculture. The transport system is the only system that is elaborated from the street map (Fig. 13). In that system, it was classified the types of the existent roads according to capillarity and accessibility.

(1) Extremely important roads to capillarity and accessibility ('primary' or 'primary_link); (2) Very important roads to capillarity and accessibility ('secondary' or 'secondary_link'); (3) Important roads to capillarity and accessibility ('tertiary' or 'tertiary_link'); (4) Medium important roads to capillarity and accessibility ('motorway' or 'motorway_link'); (5) Medium to low important roads to capillarity and accessibility ('living_street' or 'residential'); (6) Low important roads to capillarity and accessibility ('track' or 'unclassified'); (7) Very low important roads to capillarity and accessibility ('bridleway' or 'footway' or 'path' or 'pedestrian' or 'steps'); and

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(8) unimportant roads to capillarity and accessibility ('service' or 'services'). According to this classification, the capillarity and accessibility received numerical values (100, 70, 50, 25, 10, 5, 3, 1).

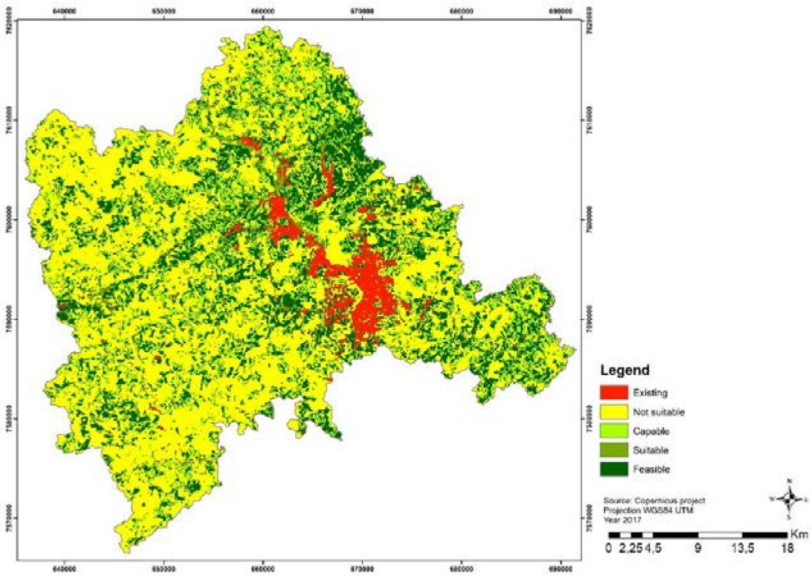

Fig.11 Urban system. Source: Authors

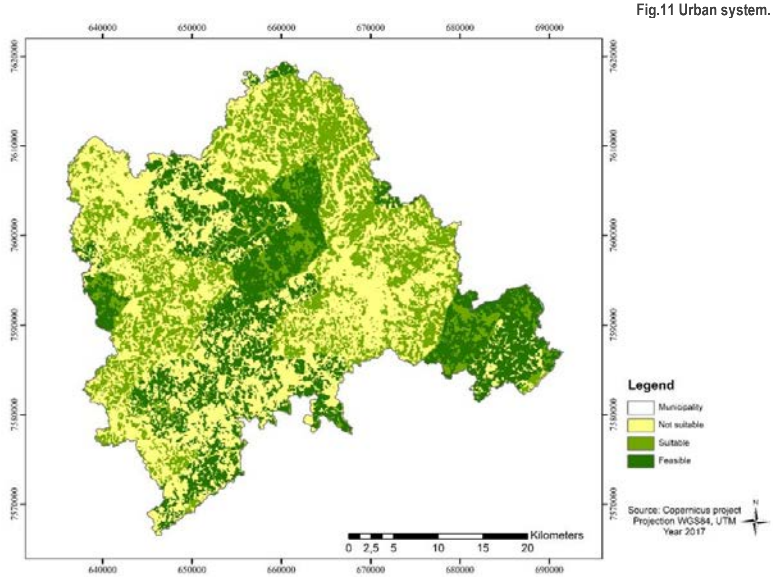

Fig.12 Agriculture system. Source: Authors

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After that, we used the Kernel Density to calculate capillarity and construct it an algebra weighted according to the value given in each classification mentioned above. The result of Kernel Density is divided into 5 ranges, using "natural break" distribution. The result was classified as "feasible" where there is low potential of capillarity and accessibility and needs to be improved a lot. The "suitable" label - where there is low to medium potential capillarity and accessibility - needs to be improved. The "capable" label - where there is medium potential of capillarity and accessibility - needs to be improved; the "not suitable" label - where there is medium to high potential capillarity and accessibility - does not need much improvement; the "existing" label where exists the high potential of capillarity and accessibility – does not need to be improved at all.

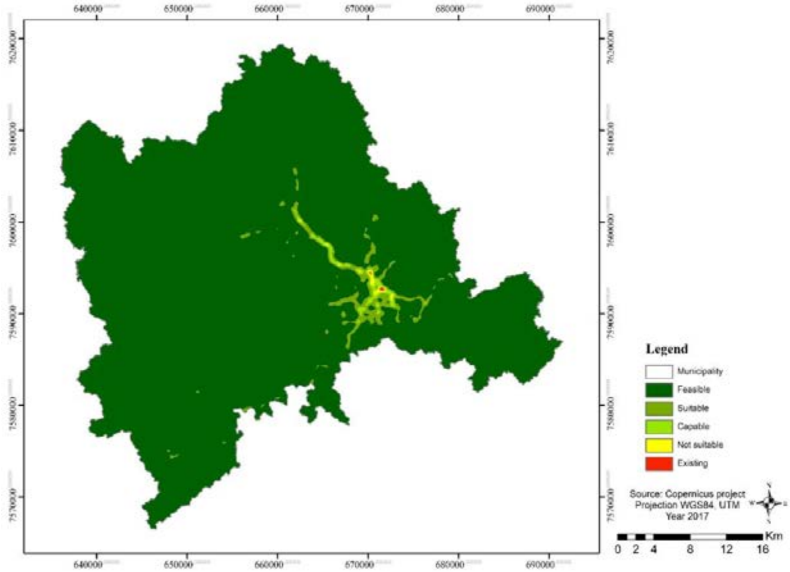

Fig.13 Transportation system. Source: Authors

In the Green System (Fig. 14), it was applied the combinatorial analysis between the NDVI map with the existent protection green areas map. The purpose of this system was to analyze the relation between the existing green cover and the protection green areas, that is, areas with potential for protection of green areas. The "existing" range (in red), shows the areas already protected in the city and that it does not need protection tools. The "not suitable" (in yellow) range shows the areas where it does not make sense to protect because it is a consolidated impervious area. The "capable" range (in light green) is where it is necessary to promote the protection of green areas. The "suitable" range (medium green color) is where it is interesting to promote the protection of green areas and the "feasible" range (dark green) is where it is necessary to protect the green areas.

The results obtained with the system maps using desktop applications method are the same produced by the webservices maps, however, the second method allows reducing the time, optimizing the production of evolution maps and using more updated data.

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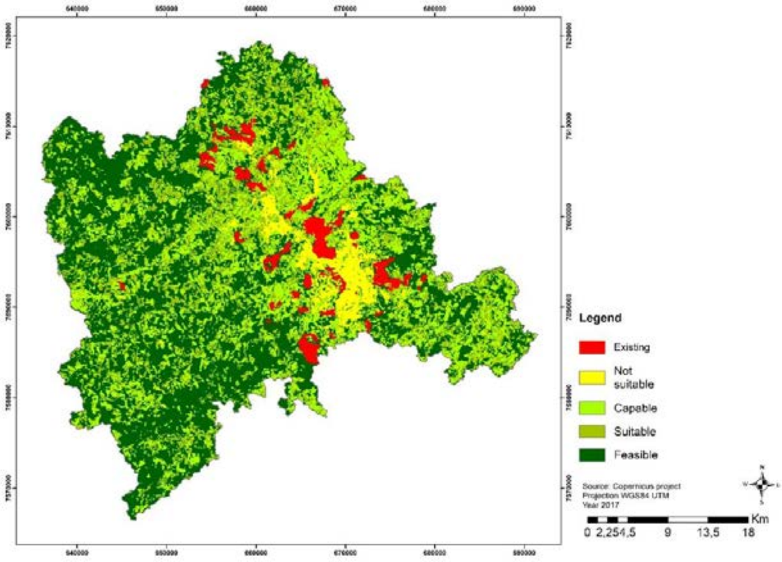

Fig.14 Green system. Source: Authors

4 CONCLUSIONS

The purpose of this paper was to construct scripts to be applied in geodesign meetings, to be offered by webservices map and to give support to Master Plans the city halls, once that the final product is already ready to be analyzed and discussed by the user. To produce the first data and evaluation systems, allowed the user's analysis of territory and identification the areas with sustainable urban growth potential for cities through a consensus between decisions. When we proposed the scripts of systems, the idea was to make dynamic data accessible to all users produced by demand, using the most recent information available in data warehouses. In this sense, users do not need to be GIS experts, but only GIS consumers, once only free access data will be used, and the municipalities will be able to have a minimum collection of dynamic evaluation models about their realities. The scripts showed good results when applied to NDVI map (land use), slope map and street map. However, they were still limited in the agriculture system and urban system to the desktop steps process, although there are studies in progress to apply the web map to solve these steps. The script is still limited about some water data because it depends on the country database, although there are indexes to analyze the water existent like NDWI (Normalized Difference Water Index). However, when this index was tested by the researchers in the urban context, it did not show good results. Perhaps, it would be interesting only applying the methodology to the rural context. The scripts showed good results of application to produce the NDVI map (land use), slope map, hydrologic map and street map. But limited to produce the systems maps, because exist some steps produced on desktop which still need more time to be worked out, although exists studies in progress to apply the webmap services to resolve these steps. Regarding methodologies, the web service method showed more interesting in relation to the traditional method, because it uses the most current data available at the platform, producing maps in a short time, allowing the production of a dynamic

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cartography without temporal clipping, which enables us to make comparisons. Thus, releases the user who is not an expert in the production of maps of analyzing and interpreting the existent data.

However, the web service method does not exclude the expert user in GIS from selecting territory data and knowing specificities about the place, being responsible for selecting consistent data for each reality. For example, slope percentage feasible with the Brazilian reality according to the ranges of slope 5%, 13%, 30%, and 47%. Because, it is important to understand that the judgment for a given data, is relative to the concept of what is acceptable or not, being able to have intrinsic cultural values of each locality.

The next steps to be developed in the tool is to allow the user to choose ranges and judgment classifications according to their values and ideals, through the dynamic cartographic, using interface windows, to allow the user to make adaptations they judge necessary.

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